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TENNYSON'S JUBILEE JEREMIAD.

"LOCKSLEY HALL," and again "Locksley Hall after Sixty Years"—in round numbers:—say since the time when the beneficent reign of the "first gentleman in Europe" came to an end, and the dignified sway of "our gallant sailor king," the father of many Fitzes, began. Our poet laureate, once peer of all the poets of his time—now a peer of the realm—has anticipated the year of Jubilee, as in duty bound, with many rhymed lines presenting the progress of his country during the fifty years (and a few years for William) over whose passage men are to rejoice this year of Jubilee.

Sad to say, the poet of the bay-leaved sherry cask, called on to bless the beneficent half century, seems more inclined to curse. He hints plainly—nay, more than plainly—that chaos has replaced cosmos. Whether there has been something "rotten in the state of Denmark," something wrong about the "beneficent sway" business, or whether (those being right who think that if England does well or if England does ill, is a matter altogether in England's own hands) England has not done so well for herself lately as she might, or whether, lastly, the new-old peer has found that all which glitters is not gold, certainly the poet laureate condemns the past half century and its products in terms by no means mild or measured. Carlyle with his Niagara-and-After screech was calm and complimentary compared with Tennyson. It is not a mere cataract, but cataclysmic chaos he sees; it is all "a sickening game," the "old dark ages back without the faith or hope," an age when "author, atheist, essayist, novelist, realist, and rhymester"

> Rip their brother's vices open, strip their own foul passions bare—
> Down with reticence, down with reverence—"Forward!"—naked let them stare;

the "budding rose of boyhood" is "fed with drainage of the sewer," "our maidens' fancies wallow in the troughs of Zolaism": in fine, the year of Jubilee finds us all in what a less elegant orator would call "a devil of a state." Surely if all this elegantly described, sickening, chaotic, foul, sewer-like, trough-wallowing abomination is real, our best provision for this year of Jubilee would be a goodly store of sackcloth and ashes. If our calm and gentle, purely writing poet laureate is right, the less Jubilee orators say about "beneficent sway" the better. If there has been sway at all, Tennyson assures us it has not been beneficent. If there has been beneficence there can have been no appreciable sway. If Tennyson is right, what considerable reason for celebrating a Jubilee remains? A nation can hardly be expected to rejoice because fifty years have passed since the "sailor king" left his fine Fitz-family fatherless. It can only be because those fifty years have been years of progress, due in some way or other to influences emanating from Balmoral, that we are going to rejoice—though, of course, celebrations of any sort must be a pleasant change for the weary drudges whom Tennyson holds in such contempt. But if our progress has been backwards, as he says, where does the rejoicing come in?

Why does our keen-sighted and even keener-nostrilled poet-peer see all this misery, this chaos, these foully-staring naked passions, these sewer-fed boys and trough-wallowing girls, where other men see in the same half century the usual mixture of good, bad, and indifferent in the nation, with some progress and especially a steady advance towards sober freedom? Why does he find "poor old heraldry" (which we could so well spare), "poor old history" (though history, at least, can hardly die), and "poor old poetry" (and very poor some old poetry is to be sure)—

> . . . Passing hence
> In the common deluge drowning old political common sense,

(which might have, at least, kept one of its extra feet on dry ground)? The whole trouble seems to lie in the extension of the suffrage by "tonguesters," who—

> Teach their flattered kings that only those who cannot read can rule.

These tonguesters, unnamed, it is, who—

> Pluck the mighty from their seat, but set no meek ones in their place,
> Pillory wisdom in their markets, pelt their offal at her face.

(Is *this* Zolaism? one wonders.) When it comes to asking who are the mighty who have been plucked down, our poet is wisely silent. He does not even tell us what meek ones might have been set in their place, but were not. Even when we ask, naturally, what these new electors have done to move his wrath, or how "the realm-ruining party" (is it, then, only a party matter after all?) have done ill, we get only some "Goosey-gander" rhymes about a cat and a lion: and after all the lion is but a carnivorous brute, while the cat, according to a poet who was more than the peer of all poets, is a harmless, necessary creature. Finally, however, we come on the real trouble:—

> Russia bursts our Indian barrier. Shall we fight her? shall we yield?
> Pause before you sound the trumpet! *Hear the voices from the field!*
> Those three hundred millions, under one imperial sceptre now,
> Shall we hold them? Shall we loose them? *Take the suffrage of the plough!*

All this, indeed, is very, very sad. Russia is an evil empire, we all know—a portentous power: and our imperial rule in India is a sacred charge. We may be a sewage-swallowing, trough-wallowing set at home, but we are purifying and ennobling our three hundred millions of Indians out yonder—*ours*, we know not why, and care not to ask how. History, arm-in-arm with heraldry, stirs poor old poetry to tell us we must sound the trumpet, and with pure and holy hands (casually armed with swords and repeating rifles) drive off those hordes of murderous, land-seizing Russians, needing only our sedulous scratching to be shown for the Tartars they are. But alas! before we can do all this for the benefit of—of—ah well, of Christianity and—and perhaps commerce, and to spread enlightenment, and so forth, and so forth—we are obliged, unfortunate that we are, to "hear the voices of the field," and "take the suffrage of the plough." Manifestly this is unfair and wrong. We may take our soldiers from the plough and drain the life blood of the field. What are the serfs for, but that? When, however, men begin to talk of hearing the drudges' voices—and alas! poor fellows, how indistinctly they often speak (mere

mutterings, as it were)—or when we invite them to give their suffrage since they have suffered and it is they who will have to suffer, then our boasted freedom is only—says the peer poet—

Free to slay herself; is dying while they shout her name.

Assuredly the extension of the suffrage is not an unmixed good. Let the fault lie where it may, a large proportion of those to whom votes have recently been given are quite incapable of forming just opinions on the matters about which they are called on to vote. (Many are not more capable, though, who think themselves born legislators, and are really but several different sorts of born noodles.) Yet it was at any rate an attempt at justice—feeble and late, but still an attempt—to give our peasants a voice after borrowing from many of them their lives generation after generation, and from most of them all that makes life worth living. Nor need those fear who would have the labourers in our fields remain as simple and as stupid as of yore. It is to be feared the poor fellows will not soon learn better. Fifty years hence it will still be possible to say what Carlyle said of them fifty years ago, when he pictured the British village Dumdrudge, contemplating in place of thirty brisk useful peasants as many dead carcasses for which "it must anew shed tears." "Had these men"—these thirty and the thirty Russians slain *per contra*—"any quarrel? Busy as the Devil is, not the smallest! They lived far enough apart; were the entirest strangers; nay, in so wide a universe, there was even unconsciously, by commerce, some mutual helpfulness between them. How then? Simpleton! their governors had fallen out; and instead of shooting one another, had the cunning to make these poor blockheads shoot." No fear, old heraldry! Hope on, old history! And poor old poetry, be joyful once more! For many Jubilee seasons yet to come the world will not have to sorrow that—

The peasant cow should butt the lion passant from his field.

The Lion *Passant* has ever been *Guardant* too; the Lion *Rampant*, *gules* (*Ruby* though not always blushingly rubescent for peers, and *Mars* for princes as old heraldry enjoins) will long take care that the peasant cow, aye, and the peasant calf and sheep and lamb, nay, even the poor, trough-wallowing pig, shall duly provide for his noble though somewhat greedy maw. If he is no longer as of yore *armed and langued sanguine* it is only because teeth and claws and saignant tongue are hidden. Even the Jeremiah of this year of Jubilee will not persuade us that the peasant cow will quickly butt the lordly lion from his fields.

All this heraldic nonsense, it will be seen, brings in its own reply, almost as nonsensical as itself. If poor old heraldry teaches poor old poetry to call the lords of fields lions, and those who till the fields mere cows, the answer, fitting the foolish saying, speaks rightly of *such* lords as having the brutal, rapacious, and carnivorous qualities of that keen-toothed, strong-clawed beast of prey. In the old days, when the fighting men who became lords of the land chose savage brutes for their knightly cognizances, savagery and brutality were not regarded as undesirable qualities; and probably most of these gallant ruffians, from my lion-hearted namesake downwards, deserved their titles as thoroughly as Chingachgook deserved to be called The Big Snake. But it is otherwise now; and poets, even poets laureate, might be better employed than in attributing to landowners the brutal qualities which of yore were essential—as the fate of all mild lords and princes showed—to the lengthy tenure of war-captured land. The fault is not amended by going outside that poor old heraldry to call our labourers "peasant cows."

THE STORY OF CREATION.

A PLAIN ACCOUNT OF EVOLUTION.

By Edward Clodd.

PART II.

Chapter III.—THE ORIGIN OF LIFE-FORMS.

MOISTURE as well as heat is essential to life; therefore life had its beginnings in water, but whether as plant or animal is a difficult question to answer. The fossil-yielding rocks tell us nothing about it, and the lowest and simplest plants and animals have so much in common that any attempt to gather evidence from them as to the priority of their respective ancestors must fail. But, however closely the earliest life-forms were related, there is fundamental difference to be drawn between their successors in the *mode of nutrition*, a difference which may throw some light upon this problem of priority, and which is not effaced by the existence of certain flesh-eating plants and vegetating animals, since this witnesses to the interchange of modifications of which protoplasm is capable.

The plant alone has the power to convert the elements of lifeless matter into the living solid state, thereby storing up energy for its own use in growth and germination, and for the use, directly or indirectly, of the animal. This the plant is enabled to do in virtue of its green colouring matter, called chlorophyll, which absorbs certain sun-rays, and sets up chemical action by which carbon is separated from oxygen in carbonic acid gas, and hydrogen from oxygen in water, forming hydro-carbons in which energy is stored up. Now if the animal is entirely dependent upon the plants for this energy, it would seem clear that they were the first to be developed.

Mr. Grant Allen has marshalled the arguments in support of their priority, drawn from the foregoing facts, in a paper of great force and clearness, which has apparently received but scant attention from biologists.* He submits that as the solar rays are, in the absence of chlorophyll, powerless to set up the separative action resulting in the material on which alone life can be sustained, the inference is obvious—no chlorophyll, no life. In other words, life being due to energy radiated from the sun, which energy is inoperative without chlorophyll, protoplasm *plus* chlorophyll is the physical basis of life.

Against this we have the opinion of authorities of the rank of Professors Ray Lankester among zoologists, and Thiselton Dyer among botanists, that the earliest protoplasm was destitute of chlorophyll. They contend that since chlorophyll is a modification of certain parts of the protoplasmic cells, it is not a thing of primary origin, but a later acquirement slowly attained. Both authorities incline to regard certain forms of fungi as representing "more closely than any other living forms the original ancestors of the whole organic world"† . . . "which existed before plants possessed chlorophyll at all."‡ But fungi, as Mr. Dyer admits, "draw their nutriment from compounds derived from other organisms, and therefore in a higher state of aggregation than those the green plants make use of, so far approaching animals in the mode of their nutrition." That is to say, fungoids are like animals; they use up the energy which the plants accumulate, and fill a secondary place in the succession of life-forms. The strength of Mr.

* *Gentleman's Magazine*, June 1885, "Genesis."

† *Encyclop. Brit.*, Art. "Protozoa, p. 832.

‡ *Ibid.*, "Biology," p. 691. Cf. also Professor Huxley's *Critique and Addresses*, p. 239.

Allen's position lies in this, that *viewing life as a product of Power operating under its separating action of Energy upon Matter*, an energy-storing organism must have come first. If the first protoplasm lacked chlorophyll, it had within it the possibilities which permitted its secretion at an early stage; it was, to use an unavoidably long word, chlorophyllaceous. The question, however, is of no serious importance in view of the common evolution of living things, and we may pass to less debatable ground in inquiry into the causes which have developed them in countless variety from specks of relatively formless protoplasm.

The cell is the structural starting-point of all life. It is a small body of sticky consistence, enclosing a nucleus, which is the result of the first visible approach of protoplasm to unlikeness of parts, and the chief centre of activity. Every cell arises by separation from a pre-existing cell, and every living organism is made up of one cell or of many cells. The single cell of which the lowest organisms are composed does everything appertaining to life: it feels, moves, feeds, and multiplies. In the complex or many-celled organisms these functions are divided among the cells, each of which is independent, but nevertheless adapts itself for the work it has to do. Division of labour causes difference of structure; stem, root, sap, leaf, and seed in the plant; bone, muscle, nerve-tissue, blood, and egg in the animal; all are communities of cells of astounding minuteness variously modified.

The one-celled forms increase by division. Growth is the balance of repair over waste, and when through assimilation of food into its substance the cell reaches a certain size, the force of cohesion is overcome by the release of the energy derived from food, and the cell divides equally at the kernel or nucleus. The slimy protoplasm distributes itself around each nucleus as the two part company, to grow and divide again in like manner *ad infinitum*. To these lowest Protozoa we may apply the words, "thou art the same, and thy years shall have no end," at least till all life here has end; for they were the Alpha, and may be the Omega, in the earth's life-history; neither is one before nor after the other, since there is no descent amongst them, but only lateral multiplication. In many Protozoa a small portion of the parent is detached, a process known as generation by budding; but this and other modes of whole or partial fission are classed together as reproduction by multiplication.

The next stage in structure is when the cells, in dividing, remain grouped together. In the plant, as has been shown already, the secretion of an envelope of cellulose round each cell, and the close union of the outer cells into a thick wall which gives stability to the structure and protection to the inner cells, causes the plant to lose touch, as it were, with the outer world, compared with the less rigid surface of the animal cells, which remained responsive in every part to stimuli from without.

The study of cell-division is profoundly interesting. The cells divide in definite order into two, then into four, then into eight, and so on, clustering together in a mulberry-like mass. Mutual pressure of the surface-cells against one another causes them to flatten into a membranous layer covering larger and denser cells. At a later stage these also spread out, the two layers forming the material out of which are developed the most complex animals. These layers, or cell-strata, which have been traced back to the first stage of division of the germ or egg, compose the double wall of the body of all animals above the Protozoa; but as we rise in the scale a third layer, larger and more complex, appears, from the subdivision of which the greater number of organs of the body, be it of a worm or a man, are developed. The upper layer gives rise to the skin, the nervous system, and organs of sense; the lower layer to the intestinal canal and appendages; and the middle layers to the general skeleton, the heart, and other important organs. The animal kingdom, treating it broadly, has therefore a threefold division—(1) simple forms, having no body cavity; (2) intermediate forms, having body cavity; (3) highest forms, having digestive cavity separate from body cavity. All have developed by slow and numberless modifications from the nucleus of a single cell, the higher passing through the grades of structure of the lower in their growth from the egg.

All plants and animals above the lowest are reproduced by the agency of special cells, the impregnation of the nucleus of the germ or egg-cell of the female by the nucleus of the sperm-cell of the male being necessary. There are numerous variations in the organs, but whatever unlikenesses exist in detail do not affect this general statement; alga and oak, sponge and man, are alike developed from germs variously called spores, sacs, seeds, and eggs. The structure of the egg of the parent determines the structure of the offspring, which, as will be shown in due course, reproduces the series of forms through which its ancestors passed as it progresses to its adult state. In other words, the individual, as it developes from the egg-cell, epitomises the history of its species.

The transmission of parental form and structure, as well as of mental character, to offspring, being clear, the question suggests itself—How have variations, resulting in millions of past and present species of plants and animals, arisen?

The ultimate causes of variations are extremely obscure, and possibly lie beyond human power to discover, but when we consider the mobility and minute complexity of structure of living things invisible to the naked eye, and their response to every shiver of energy from without, we have sufficing factors to produce unstableness which will result in unlikeness of parts. Given a body which, although a minute speck, contains billions of molecules performing complicated movements of immense rapidity, and sensitive in inconceivable degree to the play of vibrations impinging upon them at the rate of hundreds of trillions per second, would not the marvel be if these quivering particles of the structure, shaken by energies within, and by still more potent energies without, did not undergo continuous redistribution?

The position may be thus stated. The organism has—(1) Infinite complexity of structure; (2) Inherited tendencies; (3) Mobility and continuous motion, therefore tendency to vary; (4) Variations are induced by the surroundings on which, as vehicles of energy, life depends; (5) The surroundings change, and the organism adapts itself or not to the change; (6) Such as fail to do this perish; (7) Such as adapt themselves vary in greater or lesser degree; (8) These variations, being transmitted, are stages in the development of different life-forms. To put the matter briefly—likenesses are inherited, variations are acquired.

This brings us to the theory linked with Mr. Darwin's name, and which explains by what operation of natural causes the highest plants and animals have descended by true generation and slow modification from less complex life-forms, and these in ever-lessening degrees of complexity and unlikeness until the common starting-point from the lowest or one-celled organism is reached.

Following Lyell's method of explaining the past by agencies still in working, and adapting hints from Malthus and other writers in the clearing up of questions suggested by observations extending over many years, Darwin propounded a theory which, in the judgment of every biologist unfettered by predilections or prejudices, accounts in large degree for the origin of species.

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PHOTOGRAPHS OF DOUBLE STARS AND STAR CLUSTERS.*

BY MM. HENRY.

WE have obtained a certain number of good photographs of double stars and star clusters, by regulating the duration of the exposure according to the photographic intensity of the components. The magnitudes of the discs of stars as photographed in our charts of the Pleiades and of [a portion of] the Swan (see KNOWLEDGE for May and June, pp. 213, 243), which might have led to the idea that very close pairs could not be recorded photographically, were due to the long exposure necessary for stars of the lowest magnitudes; the discs grow larger with the exposure, but always begin by a minute point. A star of the first magnitude which has been on the plate but the two-hundredth part of a second, shows only a point, not a large disc. It is the same with a star of the second magnitude which has not been photographed for more than the time (0·013 sec.) necessary for recording it, and so forth. It has been found that the durations of exposure for the different orders of star magnitude are as presented in the following table:—

	Seconds.		Seconds
1st magnitude . .	0·005	6th magnitude . .	0·5
2nd „ . .	0·013	7th „ . .	1·3
3rd „ . .	0·03	8th „ . .	3
4th „ . .	0·08	9th „ . .	8
5th „ . .	0·2	10th „ . .	20
&c.,	&c.,	&c.	

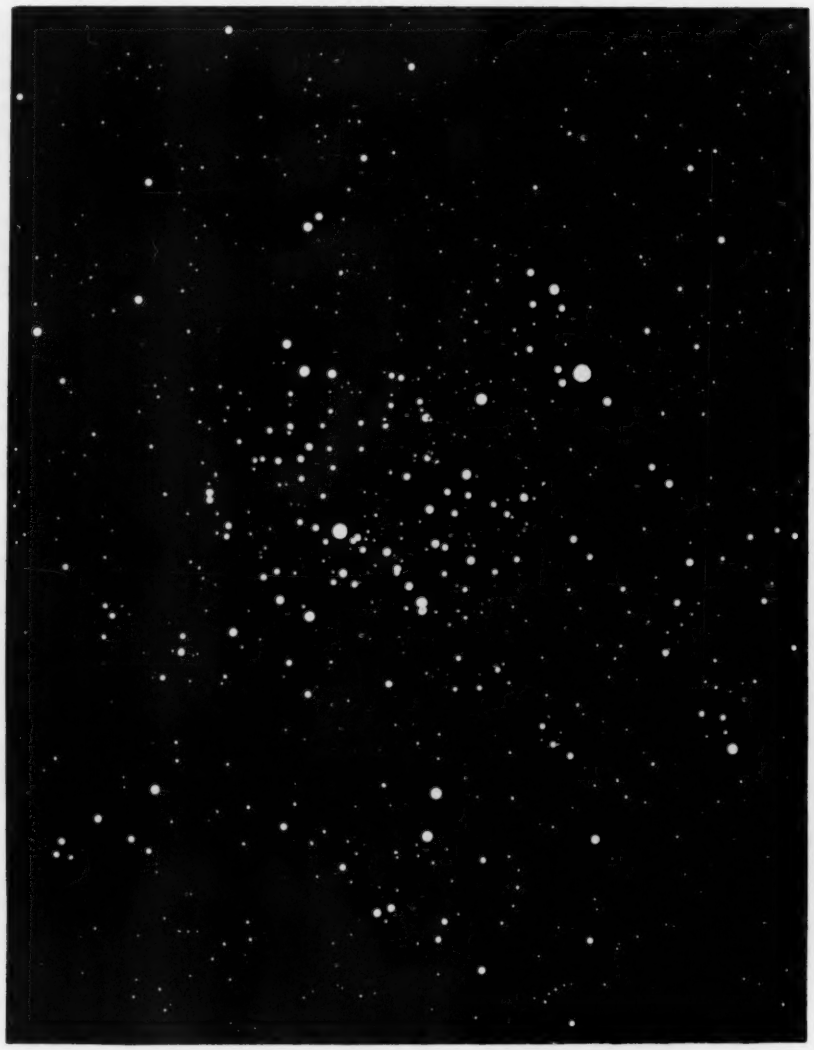

FIG. 1.—PHOTOGRAPH OF THE GREAT CLUSTER IN GEMINI. (35 Messier.)

If the exposures are not exaggerated, as they must be to obtain on the same plate stars included between the 1st or 2nd magnitude and the 16th, the stars only record themselves as minute points, and thus close doubles are self-recorded (*s'enrégistrent d'eux-mêmes*).

* From *L'Astronomie*.

Among the star clusters of which we have obtained satisfactory photographs, we present here the cluster in Gemini (Messier 35),* that magnificent cluster, 19′ in diameter, composed of stars from the eighth to the fourteenth magnitudes, whose arrangement has struck all observers. We

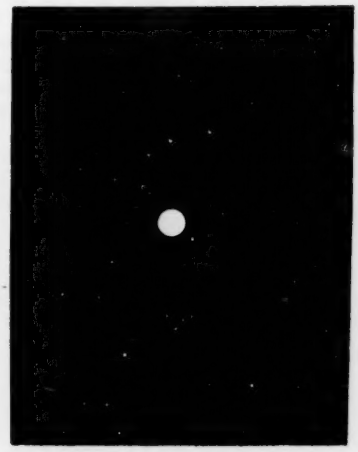

FIG. 2.—PHOTOGRAPH OF VEGA AND ITS COMPANIONS.

find here an astonishing stellar wealth which charting can only reproduce laboriously and incompletely; but photography reproduces it faithfully (fig. 1).

Let us note also in the same class of work, the group of the small companions of Vega (fig. 2), and the group of the fine quadruple star ε Lyræ (fig. 3). The magnitudes in the

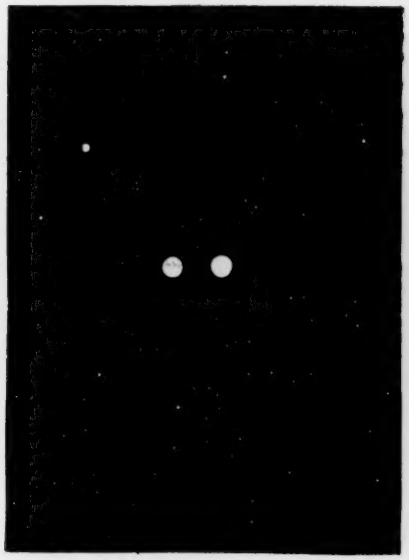

FIG. 3.—PHOTOGRAPH OF THE GROUP EPSILON LYRÆ.

former group are from the 1st to the 16th; for the latter from the 5th to the 15th. In the latter group, irradiation resulting from the length of the exposure necessary to show the very faint stars has combined the two discs of each pair into one, in such sort that we have two monstrous discs instead of two neat pairs. But as will presently be shown, these double stars have been photographed separately with a very short exposure (a quarter of a second).

Among the double stars which we have photographed and measured (in 1886), we may cite:—

	Magnitudes.	Distance.	Position-angle.
61 Cygni	5·5 and 6	20″·48	119°·7
ζ Ursæ Majoris	2·5 and 4	14·37	149·1
π Bootis	5 and 6	5·87	102·6
γ Virginis	3·0 and 3·2	5·34	333·2
44 Bootis	5·3 and 6	4·86	239·4
α Herculis	3·5 and 5·5	4·73	116·1
ρ Herculis	4·0 and 5·1	3·71	311·3
δ Serpentis	4 and 5	3·45	118·7
ϵ^1 Lyræ	6 and 7	3·06	14·3
ϵ^2 Lyræ	5·7 and 6	2·34	136·7

These direct photographs enable us to measure on the plate itself the position-angle of the components as well as the

FIG. 4.—PATH OF THE DOUBLE STAR MIZAR ON THE PHOTOGRAPHIC PLATE.
Exposure such as to show the smaller star, and therefore to present the larger as a disc.

distance. To determine the angle of position, we first, as in direct observation, allow the pair to advance in the direction of the diurnal motion, photographing itself a certain number of times along its line of motion. We thus obtain a result such as is shown in fig. 4. This line of motion is, of course, an east-and-west line, self-recorded with precision. Consequently, starting from this line, we measure the position angle on the plate itself.

In the case cited the star photographed is Mizar; the north (0°) is below, the east (90°) to the right, and the angle of position is 149°·1.

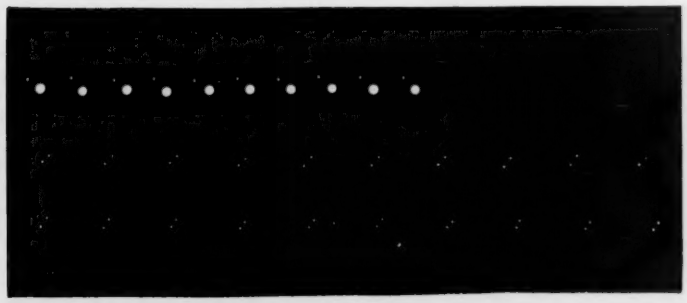

FIG. 5.—PATHS OF THE DOUBLE STARS κ BOOTIS, 58 CORVI, AND γ VIRGINIS.
Exposures varying according to the conditions

[Fig. 5 shows the pairs κ Bootis, 58 Corvi, and γ Virginis. It will be noticed that although κ Bootis is only a fourth-magnitude star, and 58 Corvi below naked-eye vision, while γ Virginis is a third-magnitude star, these differences are not recorded in the photographs, the exposure necessary for obtaining photographic records being different in these different cases. The double stars which lend themselves best to the photographic method are those whose components are nearly equal.]

Messrs. Henry describe and picture an instrument for magnifying and measuring the photographs of double stars, "a sort of stellar microscope, which gives the distances of double stars to the hundredth part of a second, by a process akin to micrometric work. Astronomers and men of science

* It lies within the limits of the Milky Way, just north of the ecliptic and east of the solstitial colure.

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interested in the study of double stars and stellar systems will no doubt be glad to learn," they add, "that photography may hereafter be applied effectively in these important researches."

MINUTE MEASUREMENT.

NO one in the least degree familiar with science in its historical aspect can be ignorant of the extent to which it has been indebted for its enormous advancement to the increased and increasing delicacy of physical measurements. Nor is this merely true in connection with any single branch of natural knowledge. Whether (taking a very few illustrations almost at random) we select the instruments employed by Tycho Brahé, for comparison with those now to be found in every first-class observatory in the world; the rude balances of the alchemists with the exquisite masterpieces of Oertling; the rough means of mechanical measurement employed by Galileo, with the fittings of a modern physical laboratory; or the screws cut by Plumier at the beginning of the last century with the mechanical marvels turned out by Sir Joseph Whitworth, we shall alike be struck with the manner in which our knowledge of those branches of science in whose pursuit they are respectively employed have advanced *pari passu* with the improvements in them. It may then be neither uninteresting nor uninstructive if we attempt to give, in a popular form, some account of the manner in which ordinarily insensible quantities are made manifest and easily measurable; and to this end we propose to describe in a familiar style some of the devices and instruments employed in the measurement of extremely minute quantities. Such description may enable those who have previously devoted but scant attention to the subject to realise with more force the trustworthiness of the data on which scientific theories are now founded, and to appreciate better the confidence with which modern men of science regard their results.

Suppose, then, in the outset, that we wish to measure a distance to the one-hundredth of an inch upon a given straight line, in what way shall we proceed to do so? Scarcely by dividing a straight scale so finely, and using that as our standard; inasmuch as the strokes of the divisions, and the intervals separating them would probably differ too little in width to be trustworthy by ordinary vision. Perhaps one-fiftieth of an inch is the smallest quantity which can be fairly employed for such a purpose by a person of average sight, and one half of this *may* be estimated. If, though, we are merely to employ estimation, a very little practice will enable us to take off quantities of this order of minuteness with considerable accuracy from a scale divided into inches and tenths, as in fig. 1,

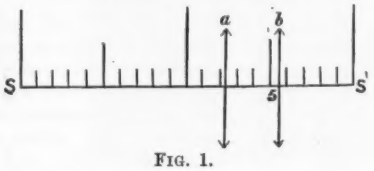

FIG. 1.

where s s′ represents a scale so divided. If now we require to take off 1½ inch from this scale, we, of course, simply place one point of our compasses on s and the other on 5 in the figure to get what we want at once. If, though, we wish to obtain a length of, say 1·22 inch, then again placing one point of our compasses on s, we extend the other to *a*, as nearly as we can estimate 0·2 division beyond the second division of our second inch, and thus we obtain the length required. In a similar way it will be seen that the distance between s and *b*=1·56 inch, and so on. But, after all, guessing to a certain extent enters into such determinations, and men of science cannot in the least degree afford to be dependent on guesswork. Let us, then, see whether we can find any more rigidly accurate method of measuring a quantity so small as that of which we have been speaking. We do find such a one in what is called the "Diagonal Scale," which is engraved on the boxwood or ivory protractor in every case of mathematical instruments—a scale which will not only enable us to measure to the one-hundredth of an inch, but to the one-hundredth of even a quarter of an inch (or the four-hundredth of an inch) if necessary. The principle on which it is constructed will be evident from a little study of fig. 2.

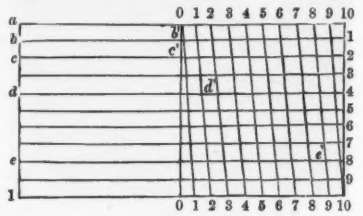

FIG. 2.

Here we see eleven equidistant parallel lines, the upper one of which is divided into two of the primary units (inches) in our figure, and perpendicular lines drawn through them. In practice, of course, the scale shown above would be extended towards the left and divided into inches, as in the case of *a* 1 *o o*. It is, however, with the right-hand one of these primary divisions that we are here more particularly concerned. This we subdivide into ten equal parts, both upon the upper and lower lines. We now draw straight lines from the zero point above to subdivision 1 below, from 1 above to 2 below, and so on, until we come to subdivision 9 above, which is joined to 10 below. Then obviously, as all these diagonal lines are parallel and equidistant at every point, while the first one coincides with the zero point at *o* on the top line, it must depart one-tenth of a subdivision from the perpendicular *o o* in the second, two-tenths in the third, three-tenths in the fourth . . . and so on to ten-tenths, or one entire subdivision on the bottom line. Then evidently *a o* = 1 inch and *a* 1 (still measuring on the top line) 1·1 inch; *b b′*, however, as will be easily seen, = 1 inch + one-tenth of one-tenth of an inch, or ·01 inch; in other words, *b b′* = 1·01 inch. Similarly, *c c′* = 1·02 inch. So again, *d d′* = ·1 inch + ·2 inch + ·04 inch—*i.e.* to 1·24 inch; as does *e e′* to 1·88 inch, and so on. For clearness, we have drawn our figure to a one-inch scale, but on the ivory protractors in cases of instruments a quarter of an inch scale will be found to be divided in this way: from which, as we have said above, $\frac{1}{400}$th of an inch should, theoretically, be susceptible of measurement. Perhaps half this quantity, though, is all that can be rigidly depended on with ordinary compasses. But in describing the construction and use of the diagonal scale, we have presupposed the employment of compasses, or something analogous, to take off the quantity we require; and it must be obvious, on the slightest reflection, that no such mode of proceeding is, or can be, applicable in such cases as those of the measurement of the height of the mercury in a barometer, or angular deviation on the "limb," or circular periphery, of a circle employed to measure angles with. It is true that a diagonal scale was engraved on the limbs of astronomical quadrants by Cantzler in England towards the end of the sixteenth century, and was adopted

by Tycho Brahé; in which case, the sharp straight edge of the observing arm, or a hair coinciding with a radius of the quadrant, cut the diagonal scale. Reference to fig. 2 (p. 78), though, will show that while absolutely true as a means of subdividing a straight measure of length, diagonal lines only afford an approximate measure of a circular arc, although this approximation was sufficiently near for the purpose of astronomers in Tycho's day. It is, however, to a certain Captain Vernier that we are indebted for a method of subdividing graduation both on straight and curved lines, remarkable at once for its elegance and accuracy. His device, now universally known as a "Vernier," must be familiar to every one who has ever seen an upright barometer or a sextant. It was originally described by him in a tract published in Brussels in 1631. The principle on which it is based may be gathered from a study of fig. 3, which represents it as applied to a common barometer.

FIG. 3.

FIG. 4.

In the figure above, S I is the scale of inches and tenths engraved on the right-hand side of the mercury tube, B M. It really starts from the surface of the quicksilver in the cistern; but as the mercury never falls much below 28 inches at the sea-level, the scale begins somewhere about there, and, as it stands, shows the height of the mercury in inches and tenths. In order, then, to measure the tenths of these tenths, or the hundredths of an inch, the vernier is employed, as shown above. In this its original form it consists of a little scale, V, measuring exactly one inch and one-tenth, but itself divided into only 10 equal parts. Now as these 10 divisions on the vernier equal to 11 on the scale of inches, it is obvious at a glance that each division of the vernier must be equal to $1\frac{1}{10}$th division of the inch scale—i.e. to $\frac{11}{100}$ths (0·11) inch. Suppose, then, that the top line on the vernier accurately coincides with any given one on the inch scale, then will that immediately below it differ $\frac{1}{100}$th of an inch from the next division on the inch scale, the second beneath it $\frac{2}{100}$ths inch from the corresponding division, and so on. Looking, then, at our figure, we see that the line marked 6 on the vernier coincides with that corresponding to 29·1 inches. Hence that marked 5 must be ·01 inch above its corresponding line, line 4 ·02, line 3 ·03, line 2 ·04, line 1 ·05, and the top of the vernier ·06 of a division above the line over which it stands. This, however, we see is 29·7, and hence the barometer reads 29·76 inches. This, as we have said, was the form of the vernier as originally devised and described by its inventor; but it will be noted that, whereas the inches and tenths of the primary scale read upwards, in this construction the hundredths are read downwards. Let us see if it be not possible to obviate the slight confusion which might arise from this, and make both scale and vernier read in the same direction. The method of doing so is extremely simple, and is illustrated in fig. 4.

Instead of dividing 11 of the primary divisions in 10 equal parts, we here take 9 of those primary parts for such divisions; so that, in the case of any two lines being coincident, the vernier line above falls short of the corresponding one on the inch scale by ·01 inch, and so on. Evidently in this case the divisions of the vernier will read upwards the same as those on the primary scale. Our figure represents the instrument as reading 29·72. In astronomical and surveying instruments and the like, the vernier thus reads forwards, though in all cases in which extreme delicacy of measurement is necessary, the vernier itself in such instruments has been superseded by the micrometer microscope, to be referred to further on. Reverting for a moment to the barometer: in all standard instruments 24 of the primary divisions, each equal to $\frac{1}{20}$th of an inch, are taken as the length of the scale of the vernier, which is divided into 25 equal parts. Hence each of these falls short of a fixed division by $\frac{1}{25}$th of $\frac{1}{20}$th or $\frac{1}{500}$th of an inch, and as this is halved in the case of the apparent coincidence of two adjacent pairs of lines, the height of the mercury is read in such instruments to the $\frac{1}{1000}$th (·001) of an inch.

After our description of the vernier, as applied to the subdivision of a straight scale, little need be added as to its application to the circular graduated "limb" of an instrument. In those mostly in popular use, such as the theodolite, sextant, and the like, the graduation on the primary arc or circle is to 30′, 20′, or 10′; then, by the aid of the vernier, these would be subdivided to 1′, 20″, or 10″ respectively. For example, if the circle is divided to 30′, then taking 29′ as the whole length of the vernier, and dividing this into 30 equal parts, in the case of two coincident lines the pair next beyond them will be separated by $\frac{1}{30}$th or 1′, the pair above that again by $\frac{2}{30}$th or 2′, and so on; and so the scale can be read to a single minute. It may serve to show how enormous is the gain from the use of the vernier in such a case if we mention that the ordinary pocket sextant, with a radius of less than 1·7 inch, is thus read to minutes: whereas if we divided a circle itself to this degree of angular minuteness and made each minute =·02 inch (smaller divisions would in such case be useless), the circle itself would have to be some $11\frac{1}{2}$ feet in diameter! If the arc were divided into 10′, then taking 59 of such primary divisions (=9°·50′ in the limb) for the total length of our vernier, and subdividing this into 60 equal parts, it will be evident that the 60th part of 10′, *i.e.* 10″, may thus be read off. Six-inch sextants are now so divided.

We cannot take leave of the vernier without inviting attention to a blunder which has been copied from book to book for the last hundred years. Sometimes it takes the form of the expression "the Nonius or Vernier," at others (as on p. 766 of Chambers's, usually marvellously accurate, "Descriptive Astronomy") we find Nonius described as the inventor of the vernier. He was nothing whatever of the sort, the "Nonius" and the "Vernier" differing wholly in principle. The attentive reader has, it is to be hoped, by this time thoroughly grasped the idea underlying the construction of the vernier. The graduation suggested by Nonius was this:—Forty-five concentric circles were to be described upon the limb of the instrument and divided into four quadrants by diameters intersecting at right angles, then the outside quadrant was to be divided into 90 equal parts, the next into 89, the third into 88, and so to the

XUM

inside one, which was to be divided into 46 equal parts. The number of each of the subdivisions was marked against its corresponding quadrant in the instrument. Now one edge of the bar carrying the sight vanes passed, when produced, through the common centre of all the circles, and Nonius supposed would cut *some* division on one of the circles accurately; then the angle corresponding to this division is calculated from the number of the divisions intercepted and the entire number in the quadrant of which the coincidence occurs. Thus, suppose that the edge were found to coincide with division 31 of the quadrant divided into 72 parts, then the arc in degrees is $\frac{31}{72}$ of 90° or 38° 45′, and so with any other circle. This device, however, never came into general use, for Tycho Brahé adopted it only soon to abandon it for the diagonal scale (of his use of which we have spoken before), and it comparatively soon died a natural death.

(*To be continued.*)

THE NATURALIST'S LABORATORY.

CONTRIBUTION VI.

LABORATORY FURNITURE—(*continued*).

CHAIRS AND TABLES.—Simplicity of design is here to be observed as a *sine quâ non*. The chairs used at the working table should be armless, of the variety generally adopted for bedrooms, or the so-called "Windsors" of the kitchen; but for comfort, elegance, and portability the Bohemian bent-wood chairs, with polished perforated wooden seats, are to be preferred before cane-bottomed or solid wooden seats. Upholstered furniture of any sort should not be permitted to enter the room, as such articles not only afford a clinging-place for dust and dirt, but are in themselves small factories of those undesirable entities. A single armed chair, however, of the kind known as the circular "office-chair," made entirely of French-polished ash or oak wood, may be placed by the side of an *escritoire*.

Of tables, four patterns may be introduced with advantage:—(α) *The Dissecting Table*—to be placed in proximity to the sink and water-supply—ought to be made of well-seasoned wood, and very firmly built. The top of the table should be about three feet above the floor, *i.e.* six or eight inches higher than an ordinary writing table. This will enable the anatomist to operate more freely whilst standing, as it will be found that much of this kind of work can be more efficiently and comfortably accomplished in that posture; but provision should additionally be made to enable the dissector to be seated, and a stool on the trivet principle, without back or arms, will be found to meet his wants most admirably.

The biologist's dissecting table shown at fig. 1 has been devised to meet the requirements of the naturalist's laboratory, private or public. It is intended as a working table for one person, but, of course, by increased dimensions the article may be modified so as to accommodate more than one worker at a time.

The black line *l* (fig. 1), over the top of the table, represents a sheet of lead or zinc, guttered crosswise across its surface, *g. g. g.*, which carry blood, washings, &c., into basin B. A longitudinal gutter, which crosses the three gutters above mentioned midway, is of course not shown in the diagram; T shows the table-top, affording a small border of wood, two inches wide, around the metal. This device allows for the attachment of dissecting hooks, connected to the subject by means of slender chains, whereby the fascia, &c., may be turned and held aside to enable the operator to work with greater ease upon any desired part. The basin B can be made to discharge into a pipe leading to a trapped sewer-gully, such as the famous "Kensington trap" of Messrs. James Stiff & Co., of Lambeth, or its contents may simply be received into a pail or bucket placed immediately beneath the orifice of discharge under the table, to be removed from time to time as occasion may require. Whilst dissecting the student will find it advantageous to keep the basin full of warm water, with a soft sponge or two at hand, wherewith to sop up extraneous humours; a plug is therefore provided at the bottom of the basin. One of the most important novelties, however, in this table is the drawer, *d*, which is fitted with a hinged board, *b*, as shown in the figure; when the drawer is pulled out the board may be made to assume the position *b′*, and

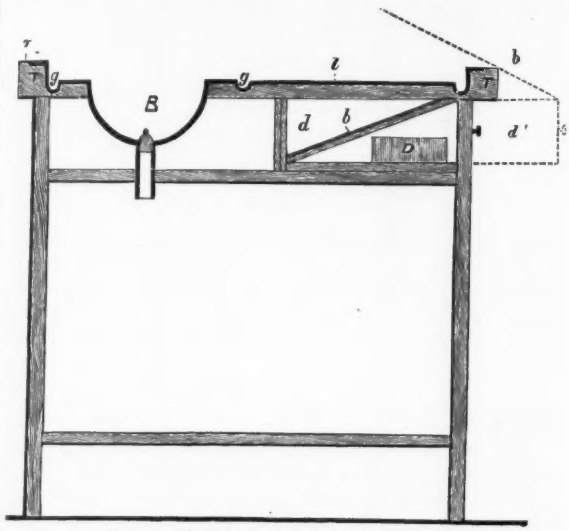

FIG. 1.—BIOLOGIST'S DISSECTING TABLE.

thus affords an extempore desk, which can be inclined at any angle to suit the convenience of the worker. It would be well to have this board fitted with a superficial pad of drawing-paper, upon which rough sketches, diagrams, and notes can be readily made of the dissection from time to time, and thus afford a lasting record of what may prove to be of considerable importance when the student comes to project a detailed description of his researches. The want of this item is a source of great annoyance to the anatomist, who often finds that his memory is apt to prove deceptive, or that his notes on scraps of paper are insufficient or mislaid when wanted; it does, in fact, supply that businesslike methodicity which reaps its own reward, alike in science as in commerce. When the drawer is closed, and the drawing-board turned down within its recess, as shown at fig. 1, *b*, it will be observed that ample space is left below it for the storage of notes and drawings taken, and for a case or two of dissecting instruments, D, boxes of pencils, ink, &c. A table thus constructed will be found most convenient for amateurs, private laboratories, and such colleges as provide separate benches for each student: it is a vast improvement on those in common use either in this country or on the Continent. The surface of the table-top should measure about 3 feet 6 inches by 2 feet. The diameter of the basin ought not to exceed 10 inches.

(β) *The Microscopist's Working Table.*—As a very large part of the naturalist's work nowadays calls into use that

most useful of modern inventions, the compound microscope, a special table designed to facilitate research must here be looked upon as something indispensable. The objects of the design, now submitted to the notice of students of nature for the first time, are to afford general convenience during study, and to enable one to record observations graphically on the spot. To accomplish these the table is divided into two parts — the microscopist's, M (fig. 2, A and B), and the artist's portion, D (fig. 2, A and B). The dimensions of the table are clearly indicated

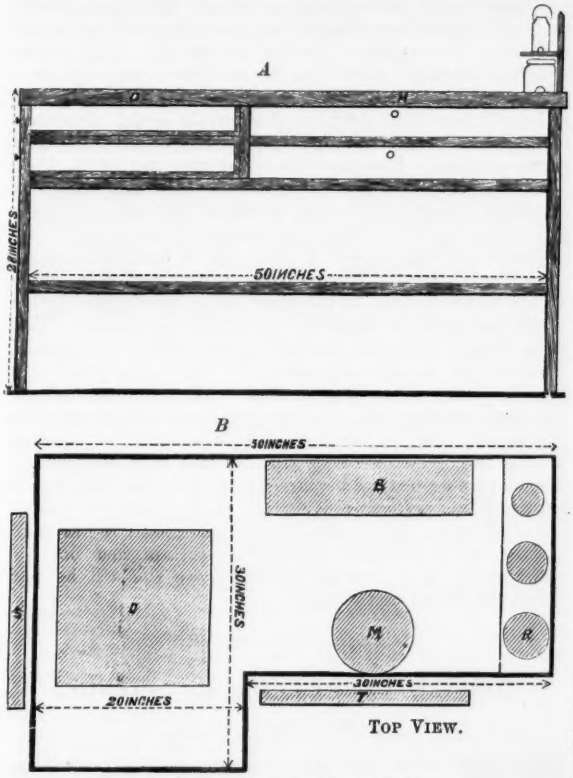

FIG. 2.—MICROSCOPIST'S WORKING TABLE.
A, Side Elevation. *B*, Top Plan.

on the figures. A, fig. 2, is a working plan to show the end elevation of the structure; B gives a good idea of the shape of the table-top. Each part is furnished with two drawers as shown at A; the drawers under D afford space for the storage of colour-boxes, pencils, paper, &c., those beneath M are intended to receive microscopical accessories, such as glass slips, instruments, live boxes, troughs, and the hundred-and-one odds and ends that may be required from time to time by the worker in Nature's unseen universe.

The longest end of the table, viz., that parallel with B, fig. 2, B, ought to face a window approximately looking northwards. The worker, seated on the bench T, fig. 2, B, can thus employ direct or reflected light according to the position, inclined, upright or horizontal, in which he places his microscope. To his right there is fixed a reagent stand, R, fig. 2, A and B. As soon as he has completed his observations, or adjusted an object which he deems worthy of delineation, he should shift his instrument to the position D, fig. 2, B, and take his seat upon the chair S, fig. 2, B. By so doing, he will gain the inestimable advantage of working in a clear transmitted light without the chance of a vitiated result through interference rays, and with absolute security against the evil effects of a more or less intense glare. The value of thus being able to shift one's position from front to side on the table will soon become evident to workers with the microscope who indulge in prolonged observations. The top plan, fig. 2, B, shows the position of the microscope during investigation, or whilst mounting objects; B, place for a dust-proof box, for use whilst preparing specimens for observation, a detailed description of which will be given in the sequel; D, the position of the microscope when used with the camera lucida for delineating objects, or when employed with the polariscope, or where pure transmitted light is alone admissible; R, the reagent stand.

(γ) *The Occasional Table.*—A round-topped table, preferably with a slate top, about 2 feet in diameter, and iron stand, is a very useful adjunct to the naturalist's laboratory. Placed by the window it affords a convenient place for overhauling and sorting the captures of a day's pond-hunt or country ramble, for noticing the life-habits of minute organisms, and for general displays. Such tables may be purchased from any dealer in microscopical apparatus, and may be seen in full working order in the laboratory of the well-known microscopist, Mr. Thomas Bolton, of Birmingham.

(δ) *The Writing Table.*—There can be no doubt that of all forms the so-called library table is the most useful here. Its large flat surface gives room for the artist to exercise his ability in making large drawings or diagrams wherewith to illustrate lectures or papers; there is also plenty of space for the current journals, in addition to elbow-room for the author. Library tables may be purchased in all sizes, to suit the dimensions of the student's apartment, from most respectable furniture dealers.

In our next contribution we shall conclude this subject, with detailed descriptions of various articles necessary to the equipment of a perfect laboratory, inclusive of such apparatus as do not strictly come under the heading of instruments for research.

THE WHIST SUPERSTITION DISPELLED.*

BY "FIVE OF CLUBS."

IF anyone were asked how often he held a singleton he would probably answer, "In one hand out of *twenty*," or some such high number. The real proportion is one in little more than *three*. Anyone who cares to note as an evening at whist proceeds, and evening after evening for a considerable time, the number of singletons he holds, or that others in the company hold, he will find that this is about the proportion shown in the long run.

The proof is not simple, because a singleton can appear in many different ways, and each requires a separate calculation. But those who possess our little treatise, "How to Play Whist," will find under the head "Whist Whittlings," in pages 194 to 197, the necessary details for the calculation; or they may take the results there collected as already calculated. The table at p. 196 shows the chance of every possible arrangement of suits in a hand, from the most frequent case—4 of each of two suits, 3 of a third, and 2 of the fourth—to the case of 13 cards of one suit. The table further shows, by the way, the chances for every possible arrangement of the 13 cards of a suit in the four hands, from the most frequent case—4 cards of the suit falling in each of two hands, 3 in a third, and 2 in the fourth—to the case of all 13 cards falling into one hand.

Now, collecting from this table at p. 196 of "How to Play Whist" all possible arrangements of the suits in a hand by

* See last number of KNOWLEDGE, p. 57.

which at least one singleton shall appear in the hand, we form the following little sum in addition :—

Arrangement.	One-fourth of the number of hands in which arrangement can appear.
5; 4; 3; 1.	20,527,933,140
6; 4; 2; 1.	7,464,702,960
6; 3; 3; 1.	5,474,115,504
5; 5; 2; 1.	5,038,674,498
4; 4; 4; 1.	4,751,836,375
7; 3; 2; 1.	2,985,881,184
6; 5; 1; 1.	1,119,705,444
7; 4; 1; 1.	622,058,580
8; 2; 2; 1.	305,374,212
8; 3; 1; 1.	186,617,574
7; 5; 1; 0.	172,262,376
6; 6; 1; 0.	114,841,584
8; 4; 1; 0.	71,775,990
9; 2; 1; 1.	28,275,390
9; 3; 1; 0.	15,950,220
10; 2; 1; 0.	1,740,024
10; 1; 1; 1.	628,342
11; 1; 1; 0.	39,546
12; 1; 0; 0.	507
Total . . .	48,882,413,450
	Multiply by 4
Grand Total . .	195,529,653,800

That is to say, there are 195,529,653,800 possible hands at whist, in which one singleton at least appears.

Now the total number of hands *possible* is no less than 635,013,559,600. Thus the chance of a hand showing one singleton at least is represented by a fraction of which this number is the denominator, and 195,529,653,800 the numerator, and such a fraction is not much less than a third. Reducing the fraction by division (by 200) we see that it may be very nearly represented by

$$\frac{97765}{317507},$$

and on applying to this the method of continued fractions we get

$$\frac{1}{3+}\ \frac{1}{4+}\ \frac{1}{26+},\ \&c.,$$

showing that the fraction is very nearly represented by $\frac{4}{13}$.

Thus each player may expect to have a singleton in his hand four times in every thirteen deals. And he may expect to find a singleton in a plain suit three times in every thirteen deals.

Now obviously we must not multiply $\frac{4}{13}$ by 4 to get the chance that in one hand of the four a singleton will appear, for that would give $\frac{16}{13}$, or *more than certainty*, for such a result, which is absurd on the face of it. The proper way to calculate the chance for four hands is as follows :—

The chance that we do not find a singleton in the first hand we examine is $\frac{9}{13}$, and the same with the second hand, the third, and the fourth; hence the chance that we do not find a singleton in any one of the four is represented (approximately) by

$$\frac{9}{13}\times\frac{9}{13}\times\frac{9}{13}\times\frac{9}{13}=\frac{6561}{28561}$$

(the last three digits of numerator and denominator being alike is an odd coincidence). Hence the chance that there will be a singleton in some hand is equal to

$$\frac{22000}{28561},$$

and the odds *in favour* of a singleton (one at least) appearing, are no less than 22,000 to 6,561, or about 7 to 2. These are not the correct odds, however, for four hands resulting from a single deal, because such hands are not independent of each other. If one hand of four dealt has the suits unequally divided, the chances are that there will be considerable irregularity in the others. The full treatment of the problem would require more work than the matter is worth. But from an approximative method I find the odds about 5 to 2 in favour of a singleton appearing in one hand at least of the four resulting from a deal. Hence, while the "nine times out of ten" mentioned in Bohn's "Handbook of Games" must be regarded as absurd, the wager offered by G. B.'s friend was short of the just odds, which are much in favour of a singleton showing somewhere. Yet no one who had not either calculated the odds for a singleton in a given hand (and thence inferred the probability of one singleton at least in four hands dealt) or observed the actual occurrence of singleton hands in a long series of deals, would think they occur so often. I suspect the cause may partly be that, while the player is apt to rejoice at the occurrence of a singleton in a plain suit (not, of course, that he would have any idea of such an iniquity as leading it), he is sure to be disgusted in much greater degree when he finds but a single trump in his hand. His pleasure in the first case, which occurs thrice as often as the other, being neutralised by his triple disgust at a singleton in trumps, the general effect is to greatly diminish the impression which a singleton, regarded *per se*, and independently of its being plain or a trump, would otherwise produce. In like manner the annoyance arising from the recognition of a singleton in an opponent's hand is neutralised by the lively satisfaction arising from the discovery that he has only one trump. The explanation may be far-fetched, but the fact to be explained is curious: it is certain that in about five deals out of seven, on the average, a singleton appears in one hand at least out of the four: it is equally certain that not one whist-player in a thousand would believe this till he had tested the matter statistically.

CONCISE EXPRESSION IN SCIENCE.

By W. Cave Thomas.

Is it not time that Scientists should express themselves more concisely than they are wont on the theory of light? To speak either of the "velocity of light" or "of light waves which have *travelled across* the illimitable depths of interstellar space," would have been perfectly correct under the Newtonian doctrine, but is incorrect, inapplicable, and misleading when applied to the "undulatory." In the first place, the theory of vibratory action in an ethereal medium teaches us that there is no *matter of light* to travel, and in the second that waves themselves do not *travel across* space, either limited or illimitable. The vibratory action initiated either by the sun or by the stars is *communicated*, telegraphed, through space, just as a wave excited at one end of a stretched cord is communicated throughout its length to the other; nevertheless, the initial wave does not *travel* the length of the cord. The inexact language I am alluding to in past and present dissertations upon the theory of light makes a thorough muddle of the Newtonian and undulatory hypotheses. Moreover, there is very much involved in the correct and clear apprehension of the facts we have cited. For if the vibrations that act upon the optic sense, and cause all the various sensations of light, are also those that act upon a sensitised plate, then we can no longer entertain the notion of a something *plus* a vibration, termed actinic

force, being associated with a ray of light. Therefore, whatever special virtues may belong to that class of rays called the "chemical," those special virtues must consist in the mechanical action of the waves of this class upon certain substances.

[I sympathise much with Mr. Thomas's purpose in the above communication. But I fear that the strict accuracy for which he stickles can hardly be secured in company with great conciseness. Let anyone try to express concisely the idea conveyed, though not with strictly verbal accuracy, by—for example—the statement that the light of such and such a star took ten years to travel across interstellar space to the earth.—R. P.]

OUR PUZZLES.

SOME correspondents complain that we give too much room to puzzles, and they are too difficult. Our puzzles have mostly been intended as mathematical recreations. Here are three which are very easy—perhaps familiar to most readers—but interesting as studies.

PUZZLE XIX. *Show how to cut a regular tetahedron (equilateral triangular pyramid) so that the face cut shall be a square: also show how to plug a square hole with a tetahedron.*

PUZZLE XX. *Show how to cut a cube so that the cut face shall be a regular hexagon: also show how to plug a hexagonal hole with a cube.*

PUZZLE XXI. *Show how to cut a regular octahedron (a double square pyramid with triangular faces) so that the cut face shall be a regular hexagon; and show how to plug a hexagonal hole with an octahedron.*

The dodecahedron and icosahedron can be cut with decagonal faces or used to fill decagonal holes. The former also served the editor as a basis for his library and school star atlases, and for the equal-surface atlas whose maps are now in progress.

SOLUTION OF LAST MONTH'S PUZZLES.

PUZZLE XVI. Box No. 1 is 11 inches square, inside measurement, in the base; and $11\frac{9}{10}$ inches deep; and the fruiterer desires to pack in it 200 oranges.

He can effect this by the arrangement illustrated in fig. 1, *a*, where the 25 darker circles represent the lowest layer of oranges, and the 25 light circles the layer next above it, the successive layers corresponding alternately with these, so that the dark circles may be regarded as showing the positions of the oranges in the 1st, 3rd, 5th, and 7th layers, the light circles representing the positions in the 2nd, 4th, 6th, and 8th.

To determine the height of the centres in any layer above those in the next lower layer, let a plane be supposed taken through the centres of the oranges *a*, *b* in the lowest layer and *c* in the layer above. (This plane will be vertical if the layers are horizontal.) Then we have the section shown in fig. 1, *b*, where the centres *a*, *b*, *c* are represented by A, B, C. Since AC=CB=2 inches, CM=$\sqrt{2}$=1·414 inch. Thus each layer rises 1·414 inch above the last; and since the lowest layer rises 2 inches above the bottom of the box, leaving $9\frac{9}{10}$ inches to the top, we are limited to as many layers above the bottom one as the (whole) number of times 1·414 inch is contained in $9\frac{9}{10}$ inches; i.e. there are 7 layers above the lowest (since 1·414×7=9·898). Thus there can be 8 layers, and it needs no proof that there can be 25 in each layer, arranged as in the figure. Consequently 200 oranges can be packed in this way. It will be shown

Fig. 1, b.

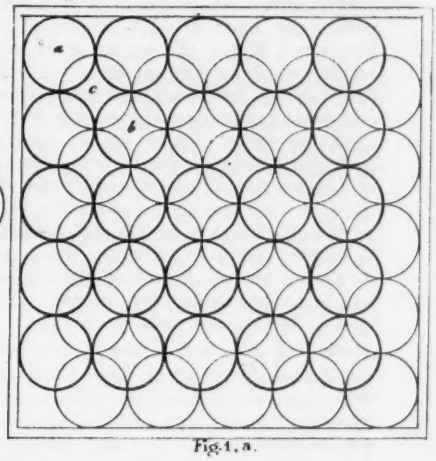

Fig. 1, a.

presently that by no other arrangement can more than 200 oranges be packed in Box No. 1.

PUZZLE XVII. Box No. 2 has a base 12 inches by $11\frac{1}{4}$ inches, inside measurement, and is $11\frac{8}{10}$ inches deep. The fruiterer has to pack in it 231 oranges.

He can effect this by the arrangement shown in fig. 2, *a*, where the dark and light circles are to be understood as before. We get in 6 and 5 in alternate rows, and 6 rows fall easily within the $11\frac{1}{4}$ inches in the lowest row, for we see from fig. 2, *b*, that *b* and *c*, the centres of the 2nd row, fall further from the side of the box than *a* does, by the distance AM=$\sqrt{3}$, or 1·73 inch. Hence, since the 1st row reaches 2 inches from the side, the sixth reaches 2+5×1·73 =10·65. But it is further manifest that *e*, the centre of an

Fig. 2, b.

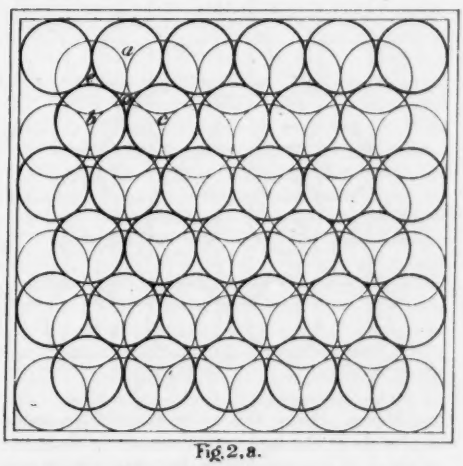

Fig. 2, a.

orange of 2nd layer, lies farther than *a* from the side by a distance equal to $\frac{1}{2}$ *ao*, or OM in fig. 2, *b*. That is each row in the upper layer overlaps by $\frac{1}{2}\sqrt{3}$, or ·58 inch, a row in the lower layer. (This, of course, is true of every layer; only in the arrangement illustrated the rows in the lower layer overlap the rows of the layer above *towards*, not *from*, the side shown at the top of the figure. Adding ·58 to 10·65, we get 11·23 inches, so that the upper layer, like the lower, can contain 6 rows and yet lie within the breadth ($11\frac{1}{4}$ inches) of the base. Thus in each layer we get 6

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rows of oranges, the rows containing alternately 6 and 5 oranges; so that each layer contains 3 times 11, or 33 oranges.

We must next determine how many layers we can get within the depth of $11\frac{8}{16}$ inches. For this we must find how much higher the centre of an orange e is above the level in which lie the centres a, b, c. But for convenience (so that fig. 2, b, may still suit us) we may suppose an orange set in the space above o, fig. 2, b; for clearly we shall have the same height in one case as the other. The centre will lie in the perpendicular from o, and at a distance of 2 inches from b, as in the other case, illustrated in fig. 1, b. Thus if we draw OD perpendicular to OB in fig. 2, b, and with BA (=2 inches) as radius describe the arc AD around B as centre cutting OD in D, we clearly have OD equal to the height we require, by which the centres of the oranges in one layer are above those in the next below [or OB=ob, BD=2 inches, and BOD is a right angle). But since $BO=OA=\frac{2}{3}\sqrt{3}$, and $BD=2$, $OD^2=4-\frac{4}{3}=\frac{8}{3}$, and $OD=2\sqrt{\frac{2}{3}}=\frac{2}{3}\sqrt{6}=\frac{2}{3}(2{\cdot}4495)=1{\cdot}633$ inch. By this amount each layer rises above the layer next below; and as the lowest is 2 inches high, and the total height is 11·8 inches, we divide 9·8 inches by 1·633, getting 6 as the number of layers above the lowest, the 7 layers reaching to a height of $2+6\times1{\cdot}633=11{\cdot}798$ inches, or falling just within the depth of the box.

The total number of oranges, since each layer contains 33, is 7×33, or 231, as required.

Puzzle XVIII. Box No. 3 is cubical—the inside length, breadth, and depth being $11\frac{9}{16}$ inches—and in this box 256 oranges are to be packed.

Here the arrangement adopted must be that shown in fig. 3, where the dark and light circles are to be understood

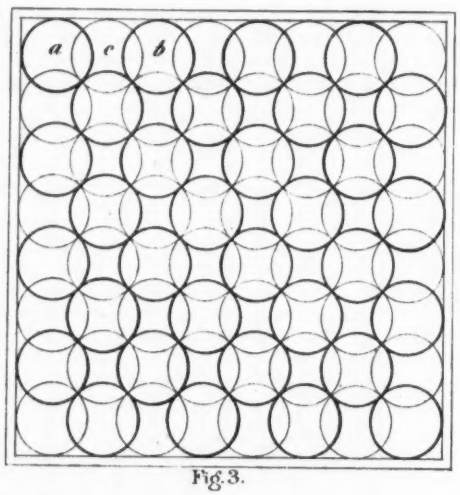

Fig. 3.

as before. Here the rows range from each other as the layers do in the first arrangement, so that, as shown by aid of fig. 1, b, in considering that case, 8 rows occupy a breadth of 11·89 inches. (We may regard a, b, and c in fig. 3 as corresponding to a, b, and c in fig. 1, a.) Moreover, we observe that the arrangement of oranges in each layer of this third box is, in a sense, the same as in the layers of box No. 1, the centres of four adjacent oranges forming a square 2 inches in the side, as in that case. Hence the layers range in height in the third case precisely as in the first, or there are 8 layers.

Since, then, there are 8 layers, and 32 in each, as fig. 3 shows, there are in all 256 oranges, as required.

It will be readily seen that the arrangement in the solution of each puzzle is the best for that special case. If we try in box No. 1 the arrangement used in box No. 2, we get in 4 layers of 30 and 3 of 25, or only 195 oranges; if the arrangement used in box No. 3, we get in 4 layers of 25 and 4 of 24, or only 196. Again, if in box No. 2 we employ arrangement No. 1, we get in 4 layers of 30 and 3 layers of 26, or only 195 oranges; and if in box No. 2 we employ arrangement No. 3, we get in 8 layers of 28, or only 224 oranges; lastly, if in box No. 3 we employ arrangement No. 1, we get in 8 layers of 25, or only 200; while if we employ arrangement No. 2, we get 7 layers of 30, or only 210 oranges.

As regards closeness of packing, the methods are in one sense identical, a dozen or so of oranges in the middle of any box being arranged relatively to each other precisely like a set of as many which can be taken from the middle of any other box. But, considered with reference to the several boxes, the methods of packing are not equally close. We may clearly represent the closeness of packing for No. 1, No. 2, and No. 3 by the number in each box divided by the cubical content of the box, getting the respective expressions $\frac{200}{(11)^2\times11{\cdot}9}$, $\frac{231}{12\times11{\cdot}23\times11{\cdot}8}$, and $\frac{256}{(11{\cdot}9)^3}$. On deducting the values of these expressions, which can be very easily done by logarithms, we obtain the following proportion:—

Packing No. 1 : Packing No. 2 : Packing No. 3 : : 1389 : 1453 : 1516.

Thus the packing is considerably closer in box No. 2 than in box No. 1, and in box No. 3 than in box No. 2.

PAST AND PRESENT VOLCANOES.

AGAIN great volcanic disturbances remind us of the energies which our earth once possessed. For they err who imagine that the uniformitarian theory, which has replaced among the geologists of our day the catastrophic theory of former times, implies forces of disturbance as great now as they were during past ages of the earth's volcanic history. The processes of upheaval and down-sinking which affect the earth's crust proceed uniformly now, the catastrophic action witnessed in earthquakes and volcanic eruptions being as nothing compared with the steady but irresistible movements all the time going on. Nay, one may almost say that eruptions and earthquakes indicate rather the interruptions of the earth's vulcanian work than its true progress. But the steady, as well as the catastrophic, action of the earth's internal forces must be recognised as far weaker now than it was in former ages. The two forms of force are doubtless related to each other in a nearly constant proportion, so that one may be inferred when the other is known. Hence, though we cannot tell from any direct evidence the energy of steady upheaval and contraction possessed by the earth in past ages of her history, for we have full evidence only as to work done and no sufficient evidence as to the time occupied in doing the work, we can safely infer what that energy was by noting the evidence of the tremendous energy with which the interruptions to that steady work went on.

Unquestionably the extrusion of matter in volcanic eruptions was a much more important work in past ages than now. We cannot go back, indeed, to the beginning. We cannot even form an opinion as to the volcanic energies of the earth in Cambrian and Silurian times, which were by

no means the earliest, though they are the earliest of which we have clear palæontological records. The eruptive powers of the earth during the whole of the primary age must have been enormously greater than during the secondary age; but the tremendous results of the action of primary volcanoes have been removed millions of years since by sub-aërial denudation. The eruptions of the secondary age, again, must have been far more tremendous than those of the tertiary age; but even of those we have but few records left. In fact, we need only consider the condition in which the products of tertiary volcanic action are now left for our study to understand how utterly unsatisfactory and imperfect must be the evidence extant in regard to the volcanoes of the secondary and primary periods.

In our own isles we find very remarkable evidence of tertiary volcanic action, yet is that evidence at least as impressive in what it suggests but leaves unsaid as in what it actually reveals. The isles of Mull and Skye may be regarded as the wrecks of enormous volcanic mountains of the tertiary age, probably more than a million years old. Each was about 30 miles in diameter, and each about 13,000 feet, probably, in height. Each continued for many thousands of years to eject from time to time enormous masses of various kinds of lava, as well as scoriæ and lapilli, such as Vesuvius and Etna eject, but in much greater quantities. Of the size of those great volcanoes, and of the tremendous energy of their eruptive powers, we have very clear evidence. But the evidence wanting speaks in its silence more impressively by far than the evidence still remaining. Of the vast mass of either volcanic mountain but the merest fragments are now left. Low mountains, little more than hills, certainly not more than a fourth the height of the former mountain masses, show where these active volcanoes once stood. All the rest has been worn and washed away by rain and wind, and snow and storm. So far back as the memory of man runs, Skye and Mull were as they are now, so slowly, though so steadfastly, do the denuding, like the upheaving, forces of the earth do their work. Yet the clear signs remain that masses not merely larger but many times larger than the whole present mass of either island above the sea-level have been destroyed. Probably seven-eighths of the former material above the sea-level has been carried away, and is now beneath the waves of ocean. If all this has been done since the tertiary age, what chance can there be of our detecting more than the merest fragments of the volcanic products of the much-longer secondary and primary periods, even though these volcanic products were ejected on a much grander scale? In yet another, and, indeed, a much more striking way, have the interior forces of the earth in the tertiary period left records of their energy. In Montana and Wyoming a tract as large as France and Germany together was covered with basaltic lava to a depth of from six or seven hundred to three or four thousand feet. In the region now occupied by the British Islands, again, from Antrim to Mull and Skye and far northwards, even perhaps continuously to the Faroe Islands in one direction and to Iceland in another, similar masses were poured forth. In the Giant's Causeway this basaltic lava has a depth not exceeding anywhere 800 feet. But among the islands opposite the western shores of Scotland there are places where the lava shows a depth of more than 3,000 feet. In the Faroe Isles a depth four times as great is indicated. The very circumstance, however, that we can determine the present thickness of these immense lava beds, compared with which all that has ever been poured out by Etna and Vesuvius, or even by Hecla, is but as a lake compared with the sea, tells us that the original thickness must have been much greater, and that the quantity which has worn and crumbled away under the action of the denuding forces of air and water must probably have equalled, if it did not exceed, even those immense masses which still remain. On the north-eastern shores of Ireland and along the south-eastern parts of Scotland we see where the ocean has cut its way into the basaltic lava, casting down the columnar blocks into which the lava had formed itself as it shrank. The regularity of the hexagonal form in most parts of the causeway is as directly a result of physical law, it may be mentioned, as the hexagonal form of the honeycomb. The basalt simply gave way, in shrinking, where resistance to cleavage was most easily overcome; and so, where uniform in material, produced uniformly hexagonal blocks, just as the bee working so as to use up the least amount of wax produces hexagonal cells, unconscious of the fact that it is working out a pretty mathematical problem. While the slow wearing away of the basaltic masses by the sea waves went on, the whole upper surface was undergoing steady denudation. Frost and thaw, snow and rain, the drying action of the sun, followed by the work of the wind in removing the dust into which the rock has been always crumbling at its surface—all these processes, scarcely affecting the aspect of the region appreciably in many centuries, must have removed a large proportion of its original mass during the hundreds of thousands of years which have elapsed since it was extruded. In Montana and Wyoming, indeed, we find comparative youth; but the way in which such youth is indicated shows what an extreme old age it signifies as compared with the periods by which we measure history. For the rivers and torrents, which in past ages have worked those channels into the rock which are called cañons, have not as yet worked their way down more than seven or eight hundred feet, many having run dry after doing that portion of the work of channel carving. When we see how slowly even the fierce rapids and mighty falls of Niagara cut away the rocks between and over which they rush, we can infer the vastness of the periods of which the great cañons of the north-western States give evidence.

All the work which Etna and Vesuvius have done since they first existed as volcanic outlets belongs but to the closing and comparatively restful portion of the history of the great mountain system of Southern Europe. They are but flank outlets, no more to be compared with the original fissures through which the core of the Alps was extruded millions of years ago, than the small side craters on their own slopes with the chief vents by which Etna and Vesuvius afford the internal forces of the earth relief. For hundreds of thousands of years those original fissures poured forth molten masses. For still vaster periods the region of fissure-ejection sank beneath a wide-spreading sea: foot by foot, yard by yard, mile by mile, the trough sank and sedimentary matter was deposited in it (so that the sea remained ever shallow), till strata ten miles deep had been formed. Then, during hundreds of thousands of years, the sea-floor, shrinking all round, shouldered up the great core of deposited matter, bending, grinding, and contorting it till, with the tremendous heat generated in the process, its whole character was altered. Denuding forces carved and chiselled out of the heterogeneous material the mountain peaks which now alone remain of the upheaved dome-shaped masses. Along the chief lines of original disturbance there is now no longer volcanic activity. On the flanks even volcanic action has for the most part died out; but far away from the core, flanking the flanks as it were of the great mountain ranges, we find a few disturbed regions, whose outlets we see in Etna, Vesuvius, Stromboli, and the rest. An outburst like the one lately in progress, representing as it does but a remnant of a remnant of the past vulcanian energies of South Europe, attests most strikingly the overwhelming might of those energies in the past.—*Times*.

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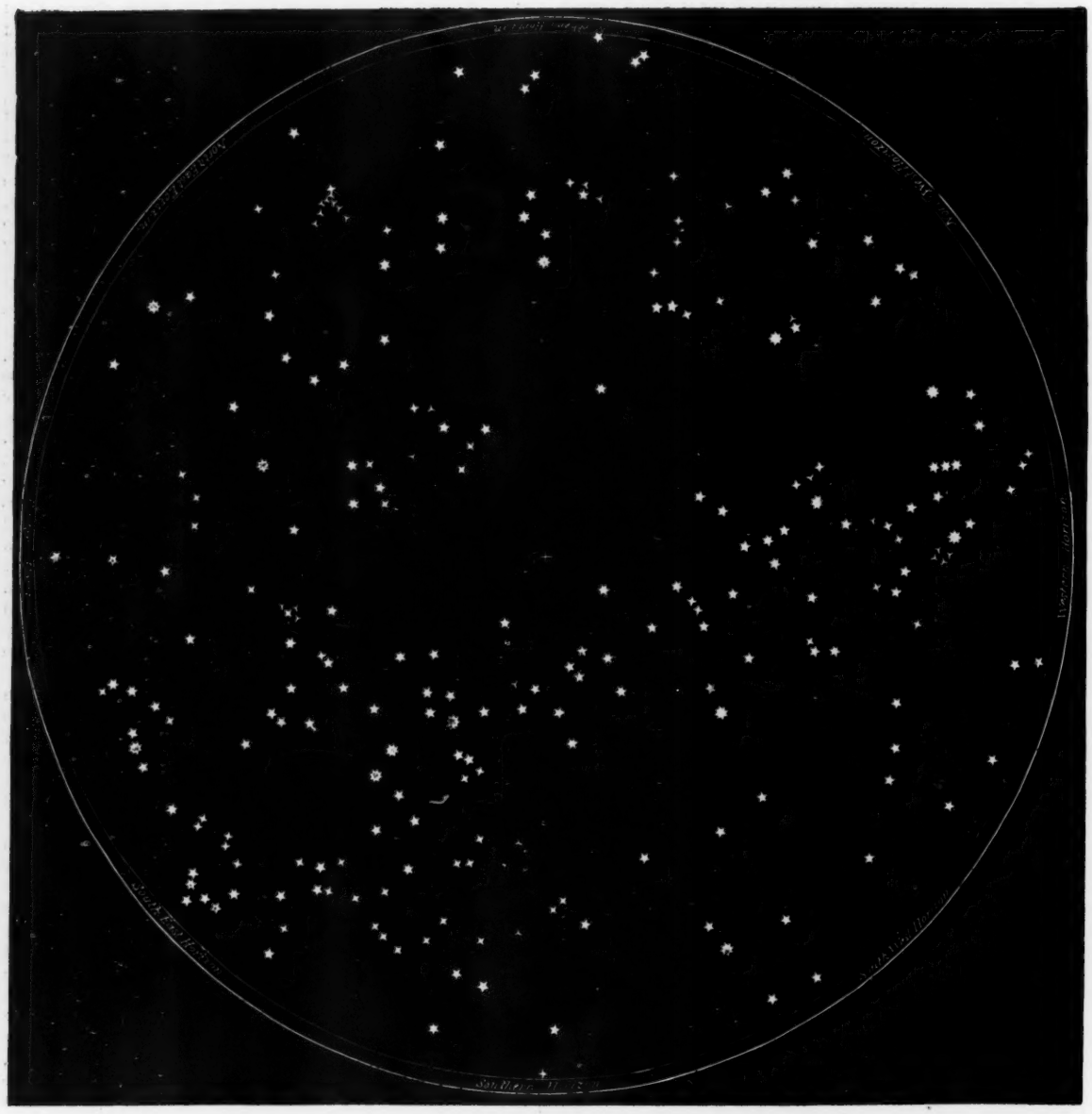


The Night Skies in the Southern Hemisphere.—For Index Map see opposite page.

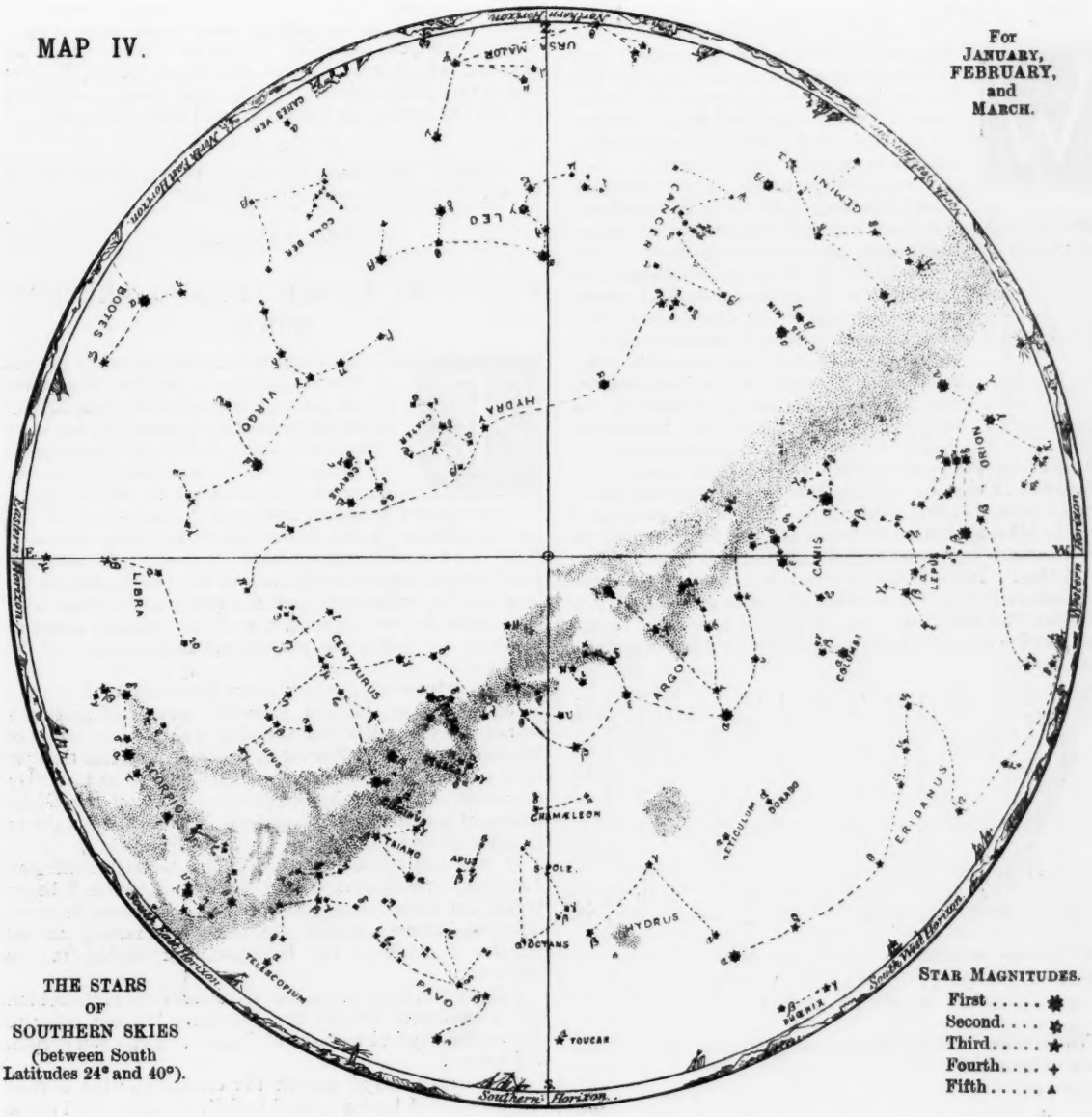
THE SOUTHERN SKIES.

By Richard A. Proctor.

OWING to the ingeniously-disturbing arrangements made by the Post-office authorities in regard to the American mails, I have not yet received proofs of the map which will appear in this month's Knowledge. Fortunately, the explanatory letterpress accompanying the maps which have already appeared will suffice to show how the map of this month is to be interpreted. It will be understood that in this map, as in the others, the horizontal line E O W marks the horizon for England, the prime vertical for the Southern heavens.

MAP IV.

For JANUARY, FEBRUARY, and MARCH.



THE STARS OF SOUTHERN SKIES (between South Latitudes 24° and 40°).

STAR MAGNITUDES.

First .....
Second....
Third.....
Fourth....
Fifth.....

THE NIGHT SKIES IN THE SOUTHERN HEMISPHERE (LAT. 46° TO 24° S.) AND THE SOUTHERN SKIES IN ENGLAND (UPPER HALF OF MAP ONLY):—

At 1 o'clock, morning	February 6.	At 10 o'clock, night	March 23.
„ 12.30 „	February 14.	„ 9.30 „	March 30.
„ Midnight	February 21.	„ 9 „	April 7.
„ 11.30 o'clock, night	March 1.	„ 8.30 „	April 14.
„ 11 „	March 8.	„ 8 „	April 22.
„ 10.30 „	March 16.	„ 7.30 „	April 30.

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ONE-SCALE ATLAS.

MAP No. II. is unavoidably postponed till next month.

THE FIFTEEN SCHOOLGIRLS' PUZZLE.

WE have received from Mr. Carpmael a very full discussion of this problem, as dealt with by him in the proceedings of the Mathematical Society. For the present, however, we can only find space for the following suggestive comments by "Mogul":

I note that you omit all reference to a mode of solving the schoolgirls' puzzle on quite different principles to any of those referred to in your last article, and which mode may be thus described:

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Describing the girls by the numbers 1 to 15 instead of by letters; thus let 1 remain in the same place all the 7 days, then arrange the remaining 14 in two series of 7 each, so that on each succeeding day every number shall occupy the place occupied the day before by the next number in the series—*e.g.* suppose one series commenced 2, 10, 13, &c., then 2 would always go where 10 was the preceding day, and the 10 be moved on to where the 13 was, &c. It does not require much consideration to show that one of the series will commence with 2 and the other with 3, so that each of these numbers may on every seventh day revert to the first row, and not come into it till then. The difficulty consists in arranging the other numbers so that in the rotation of the two series no two numbers who have ever once met shall ever meet again. One solution on this principle—for there are many of them—is as under:

(1)	1	2	3	(2)	1	14	7	(3)	1	13	5	(4)	1	4	11
	4	5	6		15	11	8		9	10	3		12	6	7
	7	8	9		5	3	12		11	7	2		10	5	14
	10	11	12		6	10	2		8	6	14		3	8	13
	13	14	15		4	13	9		15	4	12		9	15	2
(5)	1	15	10	(6)	1	9	6	(7)	1	12	8	(8)	1	2	3
	2	8	5		14	3	11		13	7	10		4	5	6
	6	11	13		8	10	4		3	6	15		7	8	9
	7	3	4		5	7	15		11	5	9		10	11	12
	12	9	14		2	12	13		14	2	4		13	14	15

And the two series are:

2	12	9	15	4	13	14
3	8	6	10	11	5	7

The sixteen whist-players can easily be solved in the same way. One solution is:

(1)	1	2	3	4	(2)	1	6	12	16	(3)	1	10	14	8
	5	6	7	8		2	10	15	7		6	9	4	15
	9	10	11	12		5	9	3	14		2	5	12	13
	13	14	15	16		11	13	4	8		3	11	16	7
(4)	1	9	13	7	(5)	1	5	11	15	(6)	1	2	3	4
	10	5	16	4		9	2	8	16		5	6	7	8
	6	2	14	11		10	6	13	3		9	10	11	12
	12	3	8	15		14	12	7	4		13	14	15	16

There being three series as follows:

2	5	9	10	6
3	11	13	14	12
4	15	7	8	16

These series are found out partly by rule and partly tentatively. Where the numbers run high, the tentative part admits of so many variations that it is very difficult to hit on the right one; and I must confess that though I have almost hit upon two series of 10 each to solve the puzzle of the 21 girls going out for 10 consecutive days in 7 rows of 3 each without any 2 ever meeting twice in the second row, I have not yet quite succeeded. I wonder whether Mr. East Marsden, who in your number for March 23, 1883, gave such a very clever solution of this very puzzle, could find out the two series; for I am convinced they must exist.

Mogul.

"Mogul" also sends a solution of the problem of 16 whist-players by the method we followed.

ASTRONOMY AT OUR EDITOR'S AMERICAN HOME.

THE following paper, while allowing readers of Knowledge to congratulate themselves on the potent influence which their faithful editor has been able to exert (for we must believe everything read in the newspapers) on the progress of astronomy in Western America, will also serve at once to give a good example of American newspaper jocularity and of the use of particular phrases in the land of the free—and easy. It is "the text of a communication to the St. Louis *Globe-Democrat*, written under the date of St. Joseph, August 21, in which the writer tells how the good people of this city have gone daft on astronomy, and how abstruse scientific problems are taking the place of practical questions of the day":—

In accordance with your positive instructions to proceed by first train to this city, "for the purpose of making a thorough investigation into the effect which the residence of Professor Richard A. Proctor in St. Joseph has had thus far upon the mental condition of its inhabitants," and to "lay the result of the inquiry before the readers of the *Globe-Democrat* without unnecessary delay," I have the honour to report as follows:

It was only when I reached Richmond and Lexington Junction, several hours distant from St. Joe, that I began to feel how powerful and widespread had Professor Proctor's influence become. While the train was resting at the junction I overhead the baggage-master saying to the conductor:

"There will be a meeting of the Pateetown Philosophical and Astronomical Society this evening. We are going to discuss the physical features of Jupiter. Can't you drop in and see us?"

"I am very sorry," replied the conductor, "but a brief lecture which I have promised to deliver before the Perigee Club of North St. Joseph will preclude the possibility of my attendance."

"On what subject will you address the club?" asked the baggage-master.

"Oh, I simply desire to lay before it a few thoughts which I have prepared on the perturbations of Uranus," replied the conductor.

It was then that I began to realise the importance of my commission, for I felt that I must be shortly landed in the very vortex of philosophical and astronomical disputation. If the railroad men, seventy-three miles away from the Professor's new American home, were filled with a burning desire to explore the mysteries of stellar space, what, thought

I, must be the passionate intensity of feeling among those who live in his immediate neighbourhood! Contemplation of the experience in store for me served only to magnify the dimensions of the task which I had been detailed to perform, and were it not that "Peanuts" came along on one of his raids through the train and pushed a volume into my hand, I might have been tempted to abandon the undertaking.

I was about to toss the book aside, thinking that it was, perhaps, a Life of Jesse James or a History of Anderson's Raid, this class of literature being popular throughout North-west Missouri, and for sale on every train, when my eye accidentally fell upon the title—"Apparent Motions of the Planets, by General James Craig." I called the "candy butcher," and, said I, "Is the General James Craig who has written this book a resident of St. Joseph?"

"Yes," replied Peanuts, "Gen. Jim Craig; don't you know him?"

"Why, of course I know Jim Craig," said I, "but I didn't know he was writing books, and least of all books of this character."

"Oh, that's where ye'r off," replied the uncultured candy butcher, "they've all got it."

"All got what?" I asked.

"This yer astronomy craze—they're all cranky on the stars."

"You don't mean to tell me that the citizens of St. Joseph are all writing books on astronomical subjects?"

"Well, pretty much all of 'em. This is Jim Craig's third—here's the other two. I sell 'em for a dollar apiece, or three for two an' a half."

He handed me the volumes. One of them was entitled "The Rings of Saturn—Are They Round or Oblong?" and the other "Density of the Fixed Stars."

"How long has this been going on?" I asked.

"Since Professor Proctor kem over," replied the boy.

He then handed me a volume on "Lunar Occultation of the Stars," by Silas Woodson, ex-governor of Missouri; another on the "Parabolic Motion of Comets," by James N. Burnes, M.C.; another on "Nebular Hypothesis," by Hon. Waller Young; another on "Meteoric Showers," by John Edwards, of the *Gazette*; another on the "Celestial Axis," by Dr. E. A. Donelan, member of the Missouri legislature, and several others on various astronomical subjects, all written by citizens of St. Joseph.

"Do you find a ready sale for these works?" I asked.

"They go beautifully," said Peanuts. "The people up this way don't read nothing else now. I can't sell no other kind of books to 'em."

"And do they pay well?"

"Yes, I should say so! There ain't much profit on 'em, but we just sell stacks."

When the train reached Plattsburg newsboys made their appearance with the St. Joseph morning papers. "Here's the *Gazette*! Full account of the discovery of a new planet!" I bought a copy. The telegraphic and local news was given a secondary place on the inside, but the astronomical intelligence appeared under flaming headlines on the first page. Such lines as "Another Triumph of Science," "A St. Joseph Astronomer Discovers a New Planet," "The Queen City of the Missouri Valley again in the Lead," "Startling Intelligence," "Rumoured Collision in the High Heavens," "A Star of the Third Magnitude Run Down by Jupiter," "August Meteors," "A Magnificent Spectacle Last Night," "Ten Thousand Telescopes Pointed toward the Sky," "Finest Display of the Season," took the place of those which usually greet the eye of the reader in the daily newspaper.

Milton Tootle, a wholesale merchant and one of the biggest capitalists in the North-West, boarded the train at Plattsburg. I introduced myself to him, and we conversed for a few moments upon the weather, the condition of trade, politics, &c., but he suddenly gave me a blow between the eyes with the question:

"Do you think that the stars which cover the universe are properly distributed through space?"

"I have not given the subject much thought of late," I replied, for I had to say something, "but my impression is that they are not."

"But why do you think they are not?" he asked.

This question took me by surprise. The subject was one I knew absolutely nothing about, and I was unprepared to discuss it. I thought I would make a break of some kind, however, so I looked him steadily in the eye and answered:

"Because Sir John Herschel tells us that, from a numerical estimate of the stars, there are more in some places than there are in others. Therefore I draw the inference that they are not properly—I should, perhaps, say evenly—distributed. It stands to reason that, if there are more stars on one side than there are on the other—there must be some difference between the——"

"Yes, yes, I understand," said Mr. Tootle, rather petulantly, I thought; "we will say no more about it. Read my book on the subject, and you will be able to talk more intelligently upon simple questions of this kind."

When the train arrived at the Union Depôt, the first sounds that reached my ear were, "Carriage here for the Mars House," "Take the street car for the Venus Hotel," "Take the Ursa Major, best two-dollars a day hotel in the city," "Step this way for the Mercury, right in the business centre."

"I want to go to the Pacific House," I said to a policeman; "where will I find it?"

"There is no Pacific House now," he said; "you are evidently in search of the Arcturus—take the 'bus."

I took the 'bus and was soon bumping through the streets of the cultured city. On the way to the hotel I observed large numbers of schoolchildren, evidently going home to their noontime lunch. Most of them carried ponderous volumes in their hands, but many had their books carted behind them in a wheelbarrow. I remarked to a fellow-passenger that St. Joseph must be a great educational centre.

"The greatest on earth," said he. "During the past two months it has become the Athens of America. Ever since Professor Proctor married a St. Joseph girl there has been a great educational revival going on here; but it was only when he came here to live that the matter began to look serious. As it is, heaven only knows where it is going to end," and my fellow-passenger sighed.

"You live here?"

"Oh, yes, I live here. I left about a month ago expecting that the epidemic would have exhausted itself before this time, but I return only to find it raging with greater virulence than ever. You see how bad it is!"

He pointed in the direction of a saloon on the window of which was the sign, "The Gemini Sample-room—sidereal entrance Sundays."

"As if that wasn't enough," he continued. "Look here!"

He pointed to a barber shop with the sign, "Transit Tonsorial Parlours," swinging across the side walk in front.

"Will you want a room with a telescope in it?" asked the clerk of the Arcturus when I had registered my name.

"No," I replied, "I want a room with a wash-stand, a pitcher of water, a bowl, and a bed in it."

"Front," said the clerk, whose diamond sparkled like a morning star, "show this gentleman to 321, fifth constellation. It is a good room," he continued, "convenient to the

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roof, from which you can watch the meteoric display to-night."

"I didn't come here to see meteoric displays at night," I replied, rather coldly. "If you've got a room where I can sleep comfortably you can give my share of the meteoric display to the other guests."

"Step this way," said the bell-boy, and he led the way to the fifth storey. "This is a dandy-room," he observed. "You will have a boss view of the big bear to-night."

"Will you tell me about what time I can get a boss view of a big dinner?" I asked.

"Dinner is ready now, sir. Will you have your instruments brought up to the room?"

"What instruments?"

"Your telescopes and things?" said the boy.

"I haven't got any telescopes," said I warmly. "Do you take me for a sea captain?"

"No, sir; but nearly all the gentlemen as stops here has telescopes."

"Well, I haven't. I've got nothing but a clean undershirt, two collars, a pair of socks, and some writing-paper. Lead the way to the banquet hall."

Being seated by a distinguished-looking darkey, I picked up the bill of fare. The *menu* was a remarkable one, and, as I am expected to go into the details, I give it in full. This is what I had to select my dinner from:

MENU.
Arcturus Hotel, Monday, August 18.
Soups.
Lunar Shadow, Solastic, Scorpio.
Fish.
Cetus, with Molecular Sauce; Sign of the Crab, with Zodiacal Gravy.
Meats.
Aries on Toast, Capricornus Sliced, Lepus Roasted, Taurus Steak.
Game.
Aquila on the Wing, Cervus Pie, Cygnus Stew, Lepus Fried.
Vegetables.
Potatoes Roasted à la Juno, Cabbage Orion, Onions Nebular, Cucumbers Comestic.
Drinks.
Milky Way, Tycho Tea, Corona Borealis Coffee.
Dessert.
Centrifugal Doughnuts, Periodic Pie, Ecliptic Pudding.

The food isn't as bad as it appears to be in the above bill of fare, and as soon as I had satisfied my appetite I ventured out on the street. The first man I met was Frank Posegate, manager of the St. Joseph Steam Printing Company. I asked him what he thought of the political situation, and he said:

"That isn't the question we are interested in here at present. You see, I am president of the Dug Hill Ecliptic Society, and we are collecting money to build an observatory. That is Dug Hill—that high bluff you see rising above the river to the left. We want to place an observatory on that hill that will equal the Lick Observatory in California. If we succeed in raising the money the discoveries we expect to make will dazzle the world."

"What discoveries do you expect to make, by the way?" I asked.

"We expect to discover, for instance," said Mr. Posegate, "that the planets do not follow regular paths between the stars, and that one of these days a large planet will plunge into the orbit of some of the stars and smash them all to pieces. The result, in such an event, would be disastrous to many heavenly bodies, and the flying particles of busted stars would be apt to work great injury to our growing crops. What we want is to establish a signal office on Dug Hill, so that the moment the planet strikes in among the stars we can give warning to the agricultural classes. Say, do you believe that our planetary system has not been sensibly diminished by the incessant emission which has gone on during the period of man's history?"

"No, I cannot say that I do," replied the *Globe-Democrat* reporter.

"Then read my book," said Mr. Posegate, "my book on 'Atmospheric Friction.' Read it and you will be convinced."

"Are you taking much interest in the origin of solar heat in St. Louis?" asked Mr. R. L. McDonald, one of the leading dry goods merchants, of your reporter.

"Yes, indeed," I replied; "we are probably taking more interest in solar heat just at present than in any other kind of heat, it being rather early to think of base burners, furnaces, or radiators."

"You misunderstand me," he said. "I alluded to the origin of solar heat—to the meteoric theory, so to speak. I have just written a small pamphlet of 300 pages on the subject. If you are not in a hurry I will read it to you."

I said I was in a desperate hurry, as I wanted to catch a train.

"Well," said he, catching me by the coat collar, "you understand that a pound weight which has fallen 772 feet will create a unit of heat. We know that a body falling that distance will acquire a velocity of about 223 feet a second. Now, I propose to sink a shaft 772 feet deep in this city, into which pound weights shall be continually dropped, with an apparatus for bringing them to the surface again. I expect to create an intense body of heat thereby; and when I have demonstrated the feasibility of my scheme I will organise a company to lay pipes from this shaft throughout the city, and we will be able to furnish heat at the rate of 10 cents per 1,000 feet to residences and business houses, entirely doing away with the necessity of stoves for cooking or heating purposes."

I went into a gentlemen's furnishing store to purchase a cheap necktie. When I had selected the article I wanted the clerk said:

"I don't agree with the leading article in the *Gazette* of this morning, which says that affinity, cohesion, and gravitation are the forces which are constantly tending to convert potential into actual energy."

"The devil you don't," said I, trying to make a bow-knot with both ends the same length in the tie I had just paid for; "then, what do you believe, if it is a fair question?"

"I believe that actual energy can be converted from the potential by the application of heat."

"I have seen," said I, for I felt bored, "potential converted into actual energy by the application of a boot."

The clerk wasn't crushed. He simply replied, "Yes; but that is what we call mechanical energy—the boot being, let us say, projected at an angle of forty-five deg——"

But I fled.

I went into a saloon to get a glass of ginger ale, and, as I stirred the sugar at the bottom, the barkeeper said:

"I have been thinking all morning that the vibration of a free pendulum in a vacuum can be explained only on the supposition that a moving body always tends to move in a straight line, and with an unvarying velocity."

"I quite agree with you," said I, "let me illustrate." I took my drink and made a bee line for the door.

There is not a solitary spot in this town where a man can go to escape from them—yes, there is just one place in all St. Joseph where astronomy and its attendant evils are not discussed. That is at Professor Proctor's home. The weary stranger, driven to the verge of madness, will find an asylum of rest and repose in the house of the Professor's family, and there only. Only two men have attempted to talk astronomy to the eminent scientist since his arrival here. One of them was found in the Professor's well a few weeks

later; the other has, it is believed, been used to test the strength of some new chemical acids which the great astronomer has recently invented.

The above is all I have been able to gather on the subject. Respectfully submitted, ANTARES.

Gossip.

By RICHARD A. PROCTOR.

A PERSON who proposes to write lives of great men of science, but who "does not pretend to know anything about the subjects in which those men of science became distinguished," asks me if I will not revise his "Life of Copernicus" for the press. No, emphatically, I will not. Nor will I revise a betting bookmaker's list of swindling wagers. Nor have I any hints to offer in aid of any other system of wrong-doing.

* * *

MY Bristol correspondent tells me I have wronged him, for which I am sorry. He also implies that his one sole object is to make me admit that the Bible is grander than the solar system. I take it the Bible was a product, directly or indirectly, of our earth, which is a part of the solar system. A product of a part cannot be greater than the whole. But if my angry friend will write out an abstract of the first two chapters of the Book of Proverbs, he will not waste paper, and he may learn a lesson, which a careful study of the Book of Job will strengthen. He will not guess my meaning; but I can't help that.

* * *

AN odd mistake appeared recently in an American paper. A translation from a note by M. Camille Flammarion appeared with the strange suffix, "From the *Camilla* (Ga.) *Flammarion*" (Camilla is the name of a small town in Georgia, and *Flammarion* is supposed to be the name of a local paper). There have been odder names, too.

* * *

A CORRESPONDENT asks my opinion on the assumption made by Kövesligethy that the solar system is travelling towards the part of the star-sphere in R.A. 216°·0 and N. Dec. 35°·1, whereas in the *Encyclopædia Britannica* I have assumed the direction of the sun's motion to be towards R.A. 260° and N. Dec. 30°. In the first place, my opinion is that the sun's motion in space cannot be regarded as determined with any approach to accuracy. In the large plate of proper motions at the end of my "Universe of Suns" the various determinations made by the elder Herschel, Argelander, Mädler, O. Struve, and others, are shown, and it will be observed that the position I indicate in the *Encyclopædia Britannica* is a very fair mean of all those widely different positions. I cannot but fancy the 216° of Herr K.'s assumed apex for the solar way must be a misprint for 246°, as none of the determinations made by astronomers fall in Bootes, as this value for the R.A., with 35° for the North Dec., would set them. If, however, Herr K. has trusted in spectroscopic evidence to determine the position of the point towards which the solar system is travelling, I can understand any amount of error. For though, as I long since pointed out, the spectroscopic evidence will probably be hereafter found the most trustworthy we can have on this subject, it is at present altogether too imperfect to be used in the discussion of such a problem as this. I would refer my correspondent to my "Essays on Astronomy," in which the whole subject is fully dealt with; but that book is now out of print, and I cannot in the present depressed state of affairs go to the expense of publishing a new edition. Perhaps when a larger public is able to turn from business anxieties to scientific studies I may do so. But it will probably be a long time hence.

* * *

THE following letter, like the one last referred to, is of somewhat ancient date, being now more than six months old. I found it among a batch received when I was leaving England in June 1885, and put away so carefully as to have escaped notice till now:

If, as you suppose in your first paper in the April number of KNOWLEDGE, the Jewish Passover was originally a feast in celebration of the passing of the sun over the equator at the vernal equinox, how do you account for the fact that the time of its celebration was determined without any reference to that astronomical event? This very year, for instance, the Passover, reckoned as of old from the first new moon in April, fell on April 20, nearly a month after the equinox. R. M. SPENCE.

* * *

THERE is no difficulty whatever in the point to which Mr. Spence here refers. We know that primarily the equinoxes were determined from the moon's motions, and the religious festivals or fasts associated with astronomical events had their origin in times when astronomical observations were, as yet, only rough. But apart from this, the rules assigned for determining the days for such festivals and fasts must be such as the unlearned can conveniently apply. No one doubts that the week had its origin in the moon's motions, or that originally it was really determined by the moon's quarters, and so had to be corrected, as in later times the year had to be. Yet now it goes on upon an easily followed method, Sabbaths and Sundays having no connection with the moon's movements. So naturally was it with the two great annual movable festivals of the Jewish calendar.

* * *

MR. SPENCE added an interesting postscript:—

The following extract from a letter which I sent to the *Scotsman* on December 29, 1883, may not be without interest to you:

"On what historic grounds are we asked to regard December 25 as the anniversary of the Nativity? Not on the authority of Scripture, for it is silent. Not on the authority of the early Fathers, for about a natal day they, too, with one exception, are silent; and that one exception, Clement of Alexandria, when he wrote his 'Stromateis' (A.D. 190–202), had never heard of December 25 as the day in question. He says ('Stromateis,' i. 21): 'There are those who have determined not only the year of our Lord's birth, but also the day, and they say that it took place in the 28th year of Augustus, and on the 25th day of Pachon' (May 20). 'Others say that He was born on the 24th or 25th of Pharmutha' (April 19 or 20). 'Not till the fourth century do we hear of December 25. It was then ingeniously adopted by the Western Church, not on historic grounds, for they had none to go on, but to make the appearance of 'The Sun of Righteousness' coincide with the resumed upward march of the natural sun, and to rival, and ultimately displace, the Pagan festivals which celebrated that physical event."

* * *

A CORRESPONDENT sends me many interesting and curious particulars relative to the names Chrishna, Jeseus, the mystic Yes, Chres, Chris, Christos, &c., of which I may hereafter make use.

* * *

A CORRESPONDENT in America (whence, by the way, I have had many valuable hints) sends the following much prettier (though practically the same) solution of the problem of the sixteen whist-players:

1st day	1st set.	Ann, Henry, Jane, Andrew.
	2nd „	Mary, John, Susan, Frank.
	3rd „	George, Laura, Tom, Sarah.
	4th „	Charley, Clara, William, Kate.

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2nd day	1st set.	Ann, Laura, William, Frank.
	2nd „	Mary, Clara, Tom, Andrew.
	3rd „	George, Henry, Susan, Sarah.
	4th „	Charley, John, Jane, Kate.
3rd day	1st set.	Ann, Mary, George, Charley.
	2nd „	Clara, Laura, John, Henry.
	3rd „	Jane, Susan, Tom, William.
	4th „	Sarah, Kate, Frank, Andrew.
4th day	1st set.	Ann, Clara, Susan, Sarah.
	2nd „	Mary, Laura, Jane, Kate.
	3rd „	George, John, William, Andrew.
	4th „	Charley, Henry, Tom, Frank.
5th day	1st set.	Ann, John, Tom, Kate.
	2nd „	Mary, Henry, William, Sarah.
	3rd „	George, Clara, Jane, Frank.
	4th „	Charley, Laura, Susan, Andrew.

Q. E. D.

* * *

THE prison puzzle in the December number ("Gossip," p. 43) may be solved in many ways if only the first few steps are rightly taken. These steps must take the prisoner into either of the cells adjoining his own, and back into his own, after which he passes out through the other neighbouring cell, and can thence find his way to the gate (fulfilling the conditions) in more ways than I care to count. It seems to me that this puzzle is rather a sell, because the prisoner certainly has to go twice out of his own cell, and can hardly, therefore, be said to have gone once, and once only, through it. However, there is no better solution; and, as I would not promise any solution at all, I have not been worse than my word.

* * *

I HAVE received another solution of the nineteen trees in ten rows problem, as shown in the accompanying figure. The same correspondent remarks that solutions given in figs. 2 and 3 (KNOWLEDGE, for November) are in reality identical. I do not agree with him in this. For wherea

in one arrangement the trees at the angles of the outside triangle fall towards the same direction (from the centre) as the bases of the interior triangle, in the other they fall towards the same direction as the angles of that triangle.

* * *

IT is told of Colonel Horatio Ross that, besides being able to shoot straight and stalk deer staunchly—qualities of themselves sufficing, in days which made Archer a sort of minor god, to raise him into the ranks of the major heroes—he was "second" in sixteen duels. The manner of his seconding was far worthier to be recalled than the mere fact, which, did it stand alone, might mean little to his credit. In every case he brought the principals to an amicable and honourable understanding. This speaks volumes for his sense and kindliness.

* * *

IT must have been another Colonel Horatio Ross who used to tell a story of a brutally-planned steeplechase, in which, following instructions, he rode down and nearly killed a brother-officer, adding the semi-idiotic comment that, he supposed, "in these shopkeeping days" had he killed the other man—Captain Douglas—"it would have been called wilful murder—but it was not so in 1826—the verdict would then have been justifiable homicide."

IT would seem we have improved in some respects—any way, in the sixty years since the time of the first "Locksley Hall." Though it is not "shopkeeping" which has taught us to regard savage horseplay with contempt. Napoleon said we were "a nation of shopkeepers" years before the gallant exploit of that other and inferior Colonel Ross. (The latter may have intended some subtle reference to that most multitudinous of all shopkeepers who erst presided over the naval, and later over the military, affairs of Great Britain.) There is no more necessary connection between shop-keeping and common sense than there is between the soldier's trade and such loutish ruffianism as the late Colonel Ross commended.

Reviews.

Pond Life: Insects. By EDWD. A. BUTLER, B.A. B.Sc. (London: Swan Sonnenschein, Lowrey, & Co. 1886.)—This fresh volume of the "Young Collector" series will suffer nothing in comparison with those of its predecessors, of which we have spoken so favourably on former occasions in these columns. Readers of KNOWLEDGE will need no reminder from us of the charm of Mr. Butler's style, and will readily accept our assurance that in his most recent volume our valued contributor is as readable and entertaining, as well as scientifically exact, as ever. Everybody who is ever likely to spend ten minutes on the bank of a pond should buy this excellent manual straightway.

Anniversary Address of the President of the Royal Society of New South Wales, delivered May 6, 1885: Local Variations and Vibrations of the Earth's Surface, and Results of Rain and River Observations made in New South Wales. By H. C. RUSSELL, B.A., F.R.A.S., &c., Government Astronomer for New South Wales. Sydney, N.S.W., 1886.—In the three pamphlets whose titles head this notice the Government Astronomer at Sydney has made a valuable contribution not only to our knowledge of the local condition of the earth's crust, and of the meteorology of New South Wales, but to terrestrial physics generally. The European astronomer and physicist will be most interested in Mr. Russell's description of the apparatus he has erected on Lake George for automatically recording the height of the water, such height varying and oscillating with every undulation of the surface of the earth. While his instrument lacks the extraordinary delicacy of Professor Darwin's pendulum and reflecting mirror, yet while any change in gravity, or in the direction of the vertical, in the latter case only affects a base of a few feet, or at most a few yards square, in the case of Lake George we have it acting on a surface twenty miles long by some five or six miles wide. Some of the results are very curious. Just as in Europe the pendulum has been noted to swing northward, or away from the Equator, during the day, and towards it at night; so at Lake George the water runs away from the equator in the daytime and approaches it at night. Mr. Russell further applies his results to the investigation of the alleged tilting of the piers of transit instruments, a portion of his work of considerable interest to the practical astronomer, and deals with the alleged rise of the land about Sydney, &c., &c.; in fact, as we commenced by saying, he has really made a valuable contribution towards our knowledge of the physics of the earth's crust.

First Year of Scientific Knowledge. By PAUL BERT. (Relfe Brothers.)—We have no school-book of elementary science which approaches this admirable work of the lamented governor of Tonkin. There is not a dry page nor

a dull paragraph in it. Stones and soils, as well as birds and flowers, are treated in a clear, chatty style, which almost makes us forget how solid is the closely-packed knowledge which it conveys. Each section is followed by a summary and by subjects for composition, while the numerous illustrations, although small in scale, are drawn with accuracy and high finish. Unlike most books, the book, like a bishop, has not suffered by translation, the excellence of which is due to Madame Bert, herself a Briton. We note an error on p. 142, where it is stated that "the earth grew cooler by turning and rolling through space," this being the opposite of the fact. Heat is a form of energy, and the cooling of the earth is due to the loss of that molecular energy which it derived from the impact of its particles as they were drawn from the gaseous to the solid state.

The Granite Crags of California. By C. F. GORDON CUMMING. (William Blackwood & Sons.)—Miss Cumming is the cheeriest of globe-trotters. Age cannot wither nor custom stale the variety of her trips and the vivacity of her descriptions. If her drawings fail—as all attempts of the kind must fail—to make us realise the astounding heights of the trees and waterfalls of the Yo-Semite valley, the letters which compose this book give vivid impressions of a country which is a veritable paradise for farmers and wine-growers. The striking geological features of the cañons, or great chasms of the American continent; the marvellous growth of San Francisco from a log settlement on swamp and sand plain to a city of 300,000, for whom the beneficent authorities provide a free railway, and whose dead are made life-like by the art of the enameller and the dentist, and laid out in caskets lined with the loveliest rose satin; stories of the gold fever and of the merciless wars between Christian whites and Heathen reds; these, and the freshly-written descriptions of Californian scenery, are the chief features of a book which it is a pleasure to read from cover to cover.

Ancient Legends, Mystic Charms and Superstitions of Ireland, with Sketches of the Irish Past. By LADY WILDE. (Ward & Downey.)—Now that folk-lore has taken rank as a serious study, and the stories of beldames are found to preserve the beliefs of a barbaric past, we expect a collector to be more than a story-teller. The accomplished compiler of these volumes has done her work so well that we regret she has not done it better. The myths and legends are all of deep interest and value, and have seemingly not been touched-up in transfer from oral to written form, but the defect, so far as their value to the student of comparative mythology is concerned, is that only the scantiest clues are given to the districts whence they were gathered. The fullest information should have been furnished with each tale as to narrator, place, and circumstance; and we hope that the issue of a second edition may enable Lady Wilde to supply this omission, as well as to add an index. Her introductory chapter on the origin and isolation of Irish legends is based upon antiquated theories, while the closing chapters on the past history of the island are marred by references to "pre-Adamic rudimental humanity," which imply retention of beliefs long discredited by anthropologists.

Marcella Grace. By ROSA MULHOLLAND. (Kegan Paul, Trench, and Co.)—We do not leave Irish soil in passing to notice this book, which lies in some danger of neglect amongst the pile of novels of a season. This should not be, for the story is one of singular strength and pathos, having special interest at the present time, when men's minds are troubled with the "Condition of Ireland" question. Not that Miss Mulholland obtrudes party politics into her vivid pictures of the peasantry and of the restless plotters who work wild, rough revenge on the land-grabber and the ejector; but the political side of social troubles cannot be ignored as giving significance to the story. The heroine is no puppet of the three-volume pattern, and the prison-scene in which her lover, on the eve of trial for a crime in which he had no part, dissuades her from perjuring herself to save him, is written with remarkable power. The book evidences throughout great pains on the authoress's part, and we commend it heartily to our readers.

In connection with it, we welcome the re-publication of *The Late Miss Hollingford*, an early tale of skilful construction by the same authoress, which was a great favourite with Charles Dickens. Messrs. Blackie and Son are the publishers.

In the Wrong Paradise and Other Stories. By ANDREW LANG. (Kegan Paul, Trench & Co.)—The story which gives its title to this sparkling book is very amusing. Each religion has its own paradise, and the fun—to the reader—consists in the departed getting into the wrong place. A Presbyterian minister finds himself in the paradise of the Ojibbeways, where he makes sport for the spirits, who scalp him at intervals, the scalp growing again immediately to permit repetition of the operation. In like manner a serious and shy University man finds himself amongst bright and large-eyed houris in the "transcendental Cremorne" of the Mohammedan paradise. But the "Romance of the First Radical" interests us most. It has the germs of the anthropological novel of the future, which is to displace Fenimore Cooper's with his *parvenu* savages. In this brightly-written but shadowed narrative of Why-Why's troubles through adoption of the new-fangled heresy of private judgment, Mr. Lang draws upon his rich store of knowledge of barbaric rite and custom. The reprint of his clever *jeu d'esprit*, "The Great Gladstone Myth," adds value to the book.

For the facts which supply material for the coming novelist of the pre-historic period, for whom Mr. Lang thus paves the way, we may call attention to two books from the pens of distinguished foreign *savants*, namely, *The Pre-History of the North*, by the late Dr. WORSAAE, translated by H. MORLAND SIMPSON (Trübner & Co.), and M. DE QUATREFAGE'S *Introduction sur l'Étude des Races Humaines*, the first volume of a general history of the races of mankind, entitled *La Bibliothèque Ethnologique* (Paris: Hennuyer; London: Trübner & Co.)—Dr. Worsaae was the distinguished director of the Royal Museum of Northern Antiquities at Copenhagen, the most complete of its kind in Europe, and the book under review gives a general and pleasantly written survey of the results arrived at by comparative examination of prehistoric materials. The Danish antiquaries were the first to throw light on the earliest-known periods of human culture, and one important result was the proof of agreement between the mode of development in various parts of the world. A succinct account of the Stone Ages, the enormous break between which the learned author does not sufficiently insist upon, is followed by local illustrations of their features in Northern Europe; and in treating of later epochs Dr. Worsaae supplies interesting material bearing on the religious rites, and notably on the worship of Thor, among Northern races. If his volume adds little of novelty to the subject, it gives us the judgment of an expert upon questions of lasting interest, and it is entitled to a place by the side of Tylor, Nilsson, Lubbock, and other authorities.

The work of M. de Quatrefages, as its title implies, is more purely ethnological. In the opening chapters on the place of man in the scale of organic life and on the theories of his origin in one or more parts of the globe, the author

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maintains the conservative view of his earlier works. We in England are well supplied with books which, like Tylor's "Anthropology," render the present work superfluous, with the exception that we have nothing like it in the collection of illustrations conveniently grouped inside one cover.

Australiana; or, My Early Life. By RICHMOND HENTY. (Sampson Low & Co.)—There is a not unpleasant egotism running throughout this book, the author of which can boast of being the first white native of the first settlement of Victoria. He has much of interest to tell us of the aborigines of the Colony, upon whom the white man's fire-water and other poisons have wrought their devastating work, and of the early condition of the settlements at the Antipodes. We wish that the space given to descriptions of his visits to the Old World and to family affairs, including the uninteresting fact to outsiders that the author's marriage took place in the presence of a large company at St. George's, Hanover Square, had been filled with details of colonial life. Upon this, however, the author has much to say that will commend his book to intending emigrants.

Historic Towns: London. By W. J. LOFTIE. (Longmans.)—This is the first volume of a series which will treat of our principal towns with reference to the special part which each has played in the general history of England. The scheme is an admirable one, in view of the growing revival of that municipal spirit amongst us which has made England the nursing mother of free governments, and the present volume could not have been entrusted to fitter hands, Mr. Loftie having proved himself in all respects a worthy successor of the chroniclers of the annals of this mightiest and most interesting of the world's cities. We especially commend this volume to young men.

Very Short Stories. By Mrs. W. K. CLIFFORD. (Walter Scott.)—The authoress of "Anyhow Stories" gives fresh evidence, in these peeps into the wonderment of child-life and "snatches of mysterious song" which make up this little book, of that weird power which attracts the old as well as young to her stories. Thoughts, the significance of which almost escape us in the simplicity of the language, are scattered with no show of art amongst the prose and verse, some of which is new, and the rest of which we are glad to greet again in this cheap and tasty form.

All Round the Clock, by H. M. BENNETT and R. E. MACK; *Christmas Roses;* and *Under the Mistletoe,* by L. LANON and R. E. MACK. (Griffith, Farran, & Co.)—If our notice of these charming books for children is a month too late to commend them as Christmas gifts, it may, in separating them from the crowd, secure them merited attention from all well-disposed sisters, cousins, and aunts who have birthday presents in view. The illustrations in each book are of exquisite softness.

The same publishers also send us a specimen of their quaint and pretty *Court Address Book,* and of both *Pettitt's and Blackwood's Diaries.* Messrs. Philips are to the fore with a *Jubilee Atlas,* which suitably embraces maps of Great Britain, India, and the Colonies. We have also received *Whitaker's Almanack,* with the present size and contents of which indispensable annual we hope Mr. Whitaker will rest as content as we are. *St. Nicholas,* which continues to be far and away the best magazine for young folks, now passes into the enterprising hands of Mr. Fisher Unwin. In *Dickens's Christmas Carol and Chimes,* Messrs. Cassell conclude the first year of their cheap and excellent weekly issue entitled "The National Library." The most attractive feature of the current number of *Longman's Magazine* is Mr. Rider Haggard's "Allan Quatermain," a sequel to his "King Solomon's Mines." Messrs. Watson Brothers (Birmingham) send us Parts IX. and X. of Mr. Teall's *British Petrography*; and Mr. Cole his instalment of *Studies in Microscopical Science,* both of which issues maintain their high excellence in text and illustration. The current number of Walford's *Antiquarian* opens with an interesting paper, the first of a series, on "Domesday Book," and gives a sprightly abstract of that rare book of travels—"Tom Coryate's Crudities."

THE FACE OF THE SKY FOR FEBRUARY.

BY F.R.A.S.

THE continued quiescence of the sun's surface renders him a very uninteresting object in the telescope. The night sky will be found depicted in map ii. of "The Stars in their Seasons." Minima of Algol will occur at 1h. 12m. A.M. on the 8th, at 10h. 1m. P.M. on the 10th, at 6h. 50m. P.M. on the 13th, and at other times too inconvenient for the ordinary amateur observer. Mercury is an evening star, and at the end of the month on very clear evenings may be detected with the naked eye a little above the horizon, somewhat to the south of west. Venus is an evening star too, and, like Mercury, may be seen for a short time after sunset at the end of February. Mars is invisible, and Jupiter does not rise until between ten and eleven o'clock at night, even at the end of the month. Saturn is visible all night long, and is a splendid object in the telescope. He is quite close to the star δ Geminorum ("The Stars in their Seasons," map ii.). Uranus is out of sight. Neptune remains in the position some $6\frac{1}{3}°$ south, and *just* to the west of the Pleiades, to which reference has been made more than once lately in these columns ("The Stars in their Sensons," map i.). The moon enters her first quarter at 8h. 26·8m. A.M. on the 1st, and is full at 10h. 43·3m. on the morning of the 8th. She enters her last quarter at 1h. 32m. A.M. on the 15th, and is new at 9h. 40·2m. P.M. on the 22nd. Of the eight occultations of stars by the moon which will happen during February, four only occur at times convenient for the amateur. They are as follow:—On the evening of the 3rd at 6h. 26m. P.M., B.A.C. 1526, a star of the 6th magnitude, will disappear at the moon's dark limb at an angle of 122° from her vertex, reappearing at her bright limb at 7h. 24m. P.M. at a vertical angle of 233°. On the 6th, 3 Cancri, a 6th magnitude star, will disappear at the dark limb at 9h. 17m. P.M. at a vertical angle of 77°. It will reappear at the bright limb at 10h. 27m. P.M., at an angle of 239° from the vertex of the moon. On the 7th, 54 Cancri, of the $6\frac{1}{2}$th magnitude, will disappear at the dark limb of the moon at 4h. 29m. P.M., at an angle of 77° from her vertex. It will reappear at her bright limb at 5h. 14m. P.M., at a vertical angle of 195°. Lastly, on the 11th, 46 Virginis, a 6th magnitude star, will disappear at the bright limb of the moon at 11h. 17m. P.M., at a vertical angle of 23°, to reappear at her dark limb at 19 minutes after midnight at an angle of 226° from her vertex. At noon to-day the moon is in Aries ("The Seasons Pictured," plate xxiii.), which at midnight she quits for Taurus. She is travelling across Taurus until 5h. 30m. P.M. on the 4th, at which hour she arrives on the boundary of the northern extension of Orion. When by 5 o'clock in the morning of the 5th she has traversed this, she emerges in Gemini ("The Seasons Pictured," plate xxiv.). Her passage through Gemini occupies her until 8h. 30m. P.M. on the 6th, when she enters Cancer; which she quits in turn for Leo, at 6h. A.M. on the 8th. She is crossing Leo until 3h. P.M. on the 10th, passing at that hour into Virgo ("The Seasons Pictured," plate xxv.). She remains in Virgo until 2h. P.M. on the 13th, when she enters Libra ("The Seasons Pictured," plate xxvi.). In the course of her journey through Libra, she comes at 8h. 30m. A.M. on the 15th to the western edge of the narrow northern strip of Scorpio. By 6 o'clock the same evening she has crossed this and entered Ophiuchus. Passing through this part of Ophiuchus and a little bit of the extreme southerly part of Serpens, she enters Sagittarius at noon on the 17th. At midnight on the 19th she leaves Sagittarius for Capricornus ("The Seasons Pictured," plate xxi.). Skirting the boundaries of Capricornus and Aquarius, after the early morning of the 21st, she finally enters the last-named constellation at 4h. A.M. on the 22nd. At 5h. A.M. on the 24th she passes out of Aquarius into Pisces ("The Seasons Pictured," plate xxii.). She is journeying through Pisces until noon on the 27th, when she quits that great straggling constellation for the north-west corner of Cetus. By 4h. A.M. on the 28th her journey across this is completed, and she has left it for Aries ("The Seasons Pictured," plate xxiii.). She is still in Aries at midnight on the 28th.

Our Chess Column.

BY "MEPHISTO."

USEFUL END-GAMES.

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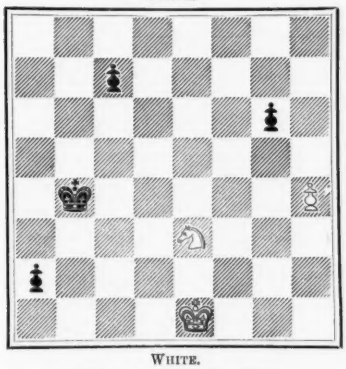

WHITE.

White to move and draw.

The above end-game position contains several points of interest which should receive the attention of chess students, and which we will endeavour to explain fully.

Firstly, in order to draw, White plays

1. Kt to B2 (ch)	1. K to B6
2. Kt to Rsq	

The opportunity often occurs to play Kt to Rsq in a similar position, and then, if the adversary's King attempts to capture the Knight, to play K to Bsq and B2 perpetually; we have shown before that, in such a position, a King alone can draw against a King, Pawn, and Knight, provided that the King occupies a square of the same colour as that on which the Knight stands, as per example Black K to QR8. P to QR7. Kt to K2. K on Qsq, White to move. White plays K to Bsq and draws, but K to B2 loses.

2.	2. K to Kt7
3. K to Q2	3. K × Kt

3. P to B4 would make no difference in the position, as White would play his K or Kt backwards and forwards.

4. K to Bsq or (*a*)	4. P to B3 !

Here we have a good illustration of the importance of losing a move. 4. P to B4 instead would have lost, as the following will show:—4. P to B4. 5. K to B2, P to B5. 6. K to Bsq, P to B6. (If P to Kt4 instead White mates in 5 moves by P to R5, &c.) 7. K to B2, P to Kt4. 8. P to R5 and mates in 4 moves. Black can only draw if he advances P to Kt4 when the White K is on Bsq, and his own P on his B6, to prevent White checking when the RP goes to Queen.

5. K to B2	5. P to B4
6. K to Bsq	6. P to B5
7. K to B2	7. P to B6
8. K to Bsq	8. P to Kt4 !

Here, again, we see that calculation and caution are necessary, for if Black had played 8. P to B7 instead, White would have won by 9. K × P, P to Kt4, and White mates in four moves.

If now 9. P × P, P to B7, and the game will be drawn. It is curious to note, however, that if White on his last move had attempted to play the move, which won in former positions, namely, 9. P to R5, it would have lost, although White Queens first, because Black will Queen with a check, as the White King stands on Bsq, and the Black P on B6 prevents White Queening with a check first. Black played 4. P to B3 instead of 4. P to B4, in order to bring this position about. If, instead of 9. P × P,

9. P to R5	9. P to Kt5
10. P to R6	10. P to Kt6
11. P to R7	11. P to Kt7
12. P to R8 (Q)	12. P to Kt8 (Q) ch
13. K to B2	13. Q to QKt8 (ch)
14. K × P	14. Q to Kt7 (ch)

and Black wins.

(*a*) Reverting again to Move 4, we find that if White plays instead of 4. K to B sq—

4. K to B2	4. P to B4 !

Black must play 4. P to B4 for the same reason which compels him to play P to B3 in answer to White's former move of 4K to Bsq, as otherwise he would lose, *i.e.* 4. P to B3; 5. K to Bsq, P to B4; 6. K to B2, P to B5; 7. K to Bsq, P to B6; 8. K to B2, P to Kt4; 9. P to R5; and mates in four moves.

5. K to Bsq	5. P to B5
6. K to B2	6. P to B6
7. K to Bsq	

and we have the same position as before in which Black plays P to Kt4, &c.

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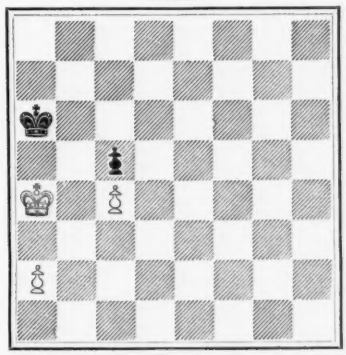

WHITE.

White to play and win.

This end-game likewise shows the importance of gaining time in order to maintain an opposition.

The White King deserves the vulgar epithet of "the sneak," for he literally sneaks into a winning position, as the following will show:—

1. K to R3 !	1. K to Kt3
2. K to Kt2 !	2. K to R4
3. K to Kt3 !	3. K to B3
4. K to B3	4. K to R4

White has already gained a most important move; for if he had simply played 1. K to Kt3, K to R4. 2. K to B3, K to R5 Black would draw, as his King is too far advanced, and does not give White time to leave his BP.

5. K to Q2 !	5. K to R5
6. K to K3 !	6. K to Kt6
7. K to Q3	And wins.

If Black plays K to R6, White captures the P, and Queens his own. Equally so if 7. K to R4; 8. K to K4, K to R3; 9. K to Q5, K to Kt3; 10. P to R3 and wins.

Attempts should be made to deviate from the above line of play, and it will be found that White cannot win otherwise than by gaining time by manœuvring his King, as shown.

PROBLEM BY RICHARD A. PROCTOR.

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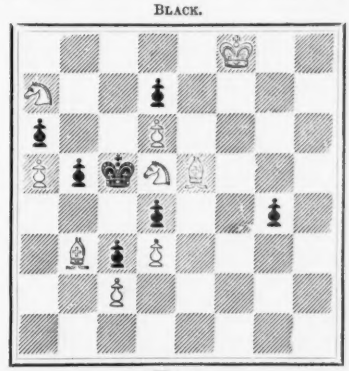


WHITE.

White to play and mate in three moves.

The author of the above problem, in contributing it to this department, says:—"I send a problem which I planned in the cars—my only opportunity for chess in any way. It is, I believe, sound, though for want of leisure I could not elaborate any difficulty worth mentioning. So if you see fit to use it, you should present it, I think, as an easy one.

"St. Joseph, Mo., November 7, 1886."

XUM

Our Whist Column.

BY "FIVE OF CLUBS."

THE *Australasian*, whose Whist column is the best now published, gives the following game as an illustration of the indirect mischief often following from the play of King second hand, from King and one other:—

THE HANDS.

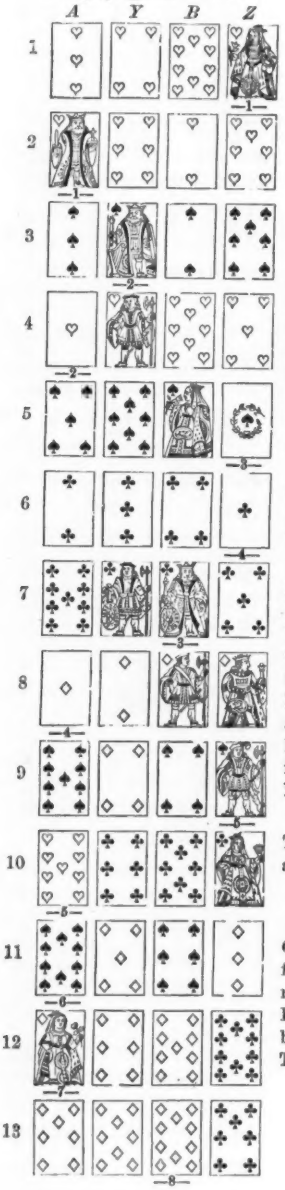
B { H. (*trumps*).—10, 8, 2. S.—Q, 6, 4, 2. C.—K, 8, 4. D.—Kn, 10, 9. }

Y { H. (*tps*).—Kn, 6, 4. S.—K, 8. C.—Kn, 6, 3. D.—8, 6, 5, 4, 2. }

Z { H. (*tps*).—Q, 7, 5. S.—A, Kn, 7. C.—A, Q, 10, 7, 5. D.—K, 3. }

A { H (*trumps*).—A, K, 9, 3. S.—10, 9, 5, 3. C.—9, 2. D.—A, Q, 7. }

A B play against *Y* and *Z*. Score:—*A B* two; *Y Z* three.



NOTES ON THE PLAY.

Card underlined wins trick; card underneath leading next.

1. *A* is right in leading trumps. But

2. *Z* is right also in playing them back on *A-B*. For he has Major Tenace in one plain suit, best and fourth best in another, and a guarded King in the third. Moreover, he is leading through strength and up to declared weakness. Yet this lead, through *Y*'s weak play, leads to ruin.

3. *Y* obeys the old rule, King ever, Queen never; and has the satisfaction of believing for a little while that he has gained a trick.

4. But why does he lead trumps? He should have *known* that *A* led trumps because he wanted to be led up to in trumps, while *Z* led them because he wanted to be led up to in any plain suit. *Y*'s play here destroys *Y-Z*, horse, foot, and artillery. *Y* should have led Club Knave. Would he have done so if he had remembered that *Z* still held the trump card? I doubt it.

6. *Z* must now lead from his Tenace. Had *Y* led Club Knave all would still have been well.

8. *Z* must cover.

9. By holding back the Diamond Queen *A* somewhat increases (so far as he knows) the chance of making two tricks in Diamonds. Probably, however, as turns out to be the case, *B* holds Diamond Ten.

And *A B* score two by cards.

The game should have been played as follows:—

	A	*Y*	*B*	*Z*
1.—	H 3	H 4	H 10	H Q
				—1—
2.—	H K	H 6	H 2	H 7
	—1—			
3.—	S 3	S 8	S Q	S A
				—2—
4.—	H A	H Kn	H 8	H 5
	—2—			
5.—	S 5	S K	S 2	S 7
		—3—		
6.—	C 2	C Kn	C K	C A
				—4—
7.—	C 9	C 3	C 4	C Q
				—5—
8.—	H 9	C 6	C 8	C 10
	—3—			
9.—	S 9	D 2	S 4	S Kn
				—6—
10.—	D 7	D 4	S 6	C 7
				—7—
11.—	D Q	D 5	D 9	C 5
				—8—
12.—	D A	D 6	D 10	D K
	—4—			
13.—	S 10	D 8	D Kn	D 3
	—5—			

And *Y Z* score two by cards and the game.

NOTES.

3. By holding back the King *Y* increases his chance of leading up to *Z*, as *Z* manifestly (to any Whist-playing partner) desires.

6. *Y*'s lead kills the enemy's Club King, and

7, 8 enables *Z* to force out the long trump.

12. *Z*'s Diamond King, though it falls, has been a tower of strength to him all the same. But for it and its useful guard, a Diamond lead by *A* at trick 9 would have given *A-B* three tricks in Diamonds.

It is noteworthy and full of meaning that, while members of all religious persuasions are very ready to accuse of blasphemy any who question the scientific accuracy of statements in the books they consider inspired, the converse charge of blasphemy in regarding inaccurate statements as inspired is very seldom heard. It seems to many reasonable enough to say, "You are wicked to recognise error in what God has written," but few think of saying, "You are wicked to recognise God's writing in what is erroneous." Possibly this is because the many who do not think are not only blind to error, but cannot see the absurdity of imagining men adopting a belief out of pure wickedness of heart; while the few who think for themselves not only recognise error, but see also that belief even in error cannot conceivably be a wilful sin. If a man should say to a student of zoology, "You must be very wicked to say the hare does not chew the cud, for God says in Leviticus that the hare *does* chew the cud," the student cannot retort, "You must be very wicked to assert that God says the hare chews the cud, when the hare himself declines to do anything of the sort;" for the same reasoning power which enables the student of knowledge to ascertain that the hare is really unable to chew the cud enables him also to see that the man who accuses him of blasphemy for recognising a scientific fact is really unable to recognise the absurdity of the idea.

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